Future for Fish

ELECTRICAL STUNNING SYSTEM

TÜRKİYE REVIEW

Future For Fish

November 2023

Colophon

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This brief report aims to provide a summary of a more comprehensive study. For detailed information, please refer to the full version of the main report.

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Çiftlik Hayvanlarını Koruma Derneği, 2023

Future For Fish

ANIMAL CHARITY EVALUATORS RECOMMENDED CHARITY 2023

AÇIK AÇIK

EXECUTIVE SUMMARY

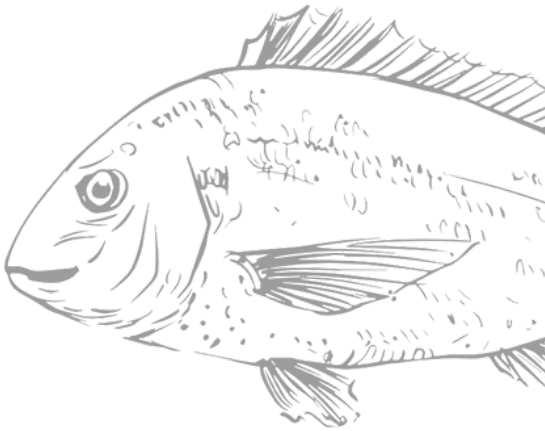
Recent research has emphasised the importance of harvesting methods by providing evidence that fish, too, can experience suffering. . The use of methods like the electrical stunning system ("ESS") by the aquaculture companies, which induces instant loss of consciousness in fish, is crucial for minimising their pain, as highlighted in this report.

This report reviews fish welfare and harvesting practices in the gilthead seabream and European seabass farming sector in Türkiye to increase the use of more humane harvesting methods. Türkiye is the world leader in production in the aquaculture sector, especially in the gilthead seabream and European seabass industry, so it is essential to assess fish welfare initiatives in Türkiye.

Fish welfare correlates linearly with fish health, production efficiency, and quality. This relationship supports the notion that elevated fish welfare standards not only enhance product quality in the market but also position producers as leaders.Current research examines the use of electrical stunning specifically in the gilthead seabream (Sparus aurata) and European seabass (Dicentrarchus labrax) farming sector. Within the scope of the report, interviews were held with leading producers of European seabass and gilthead seabream. Based on the findings from the interviews, Turkish European seabass and gilthead seabream producers comply with world-approved standards regarding fish welfare, such as keeping the stocking density below 15 kg/m3, paying attention to feeding rates and times, using appropriate methods in fish transfer, and ensuring that the water parameters in the aquaculture environment are in optimum conditions. However, it was also determined that although nine out of ten companies interviewed possessed at least one electrical stunning system, they did not use this harvesting method for 100% of their harvest.

Various factors, including market demand, equipment costs, technical constraints, and adaptability of the system to boats, are among the challenges of using electrical stunning in Türkiye. Yet, all interviews show that the advantages of electrical stunning, such as improved product quality, less pain and stress, and increased consumer satisfaction, outweigh the disadvantages. Still, it is important not to overlook the challenges faced by aquaculture companies in the use of electrical stunning. This report examines the relationship between using electrical stunning as a harvesting method and fish welfare. It suggests the need for collaboration between retailers and consumers, definition of the best methods for fish welfare by fish species through the efforts of producer associations, universities, and government institutions, dissemination of these methods throughout the sector, and joint efforts by fish producers and equipment manufacturers to implement necessary changes in electrical stunning.

As a result, the adoption of more humane harvesting practices in the aquaculture industry not only supports fish welfare standards but also increases product quality and market competitiveness. Overcoming these problems and promoting electrical stunning requires active cooperation between producers, equipment manufacturers, researchers, and associations dedicated to fish welfare.



CONTENT

1. Introduction

With the increasing human population in the last fifty years, the number of fish produced worldwide has quadrupled. An average person consumes almost twice as many fish today compared to fifty years ago. Currently, more than 100 million tons of fish are produced globally in the aquaculture sector, and the number of fish farmed has exceeded the number of fish caught. [1] This makes farmed fish one of the most cultivated farm animals, even though they are cold-blooded creatures. Considering the number of fish produced, the aquaculture sector has grown rapidly in the world and in Türkiye, which, in parallel, has led to increased awareness of environmental problems and fish welfare. [2]

In recent years, some possible evidence has been presented regarding the capacity of fish to experience pain. This evidence argues that fish can feel emotional and physical pain. [3,4,5] Therefore, the use of painful methods to kill fish, which are sentient beings, should be avoided, and the least painful killing methods should be chosen. This involves effectively stunning fish, rendering them unconscious instantly, and ensuring they remain in a state of unconsciousness until the moment of death, unaware of their surroundings.

With the number of farmed fish, Türkiye holds a significant position in the aquaculture sector in Europe and globally. To express this in figures, Türkiye ranks 10th in the world in offshore aquaculture with a production of 335,644 tons. When compared to the production in European Union countries, we see that Türkiye is the leader and the largest European seabass (*Dicentrarchus labrax*) and gilthead seabream (*Sparus aurata*) producer in

[1] Ritchie, Hannah, and Max Roser. "Fish and Overfishing." Our World in Data, ourworldindata.org/fish-and-overfishing#global-fish-production

[2] Çoban, D., Demircan, M.D., Tosun, D.D. (Eds.). Marine Aquaculture in Turkey: Advancements and Management. Turkish Marine Research Foundation (TUDAV) 2020 Publication No: 59, İstanbul, Türkiye, 430.

[3] K.P Chandroo, I.J.H Duncan, and R.D Moccia, "Can Fish Suffer?: Perspectives on Sentience, Pain, Fear and Stress," *Applied Animal Behaviour Science* 86, no. 3–4 (2004): 225–50, https://doi.org/10.1016/j.applanim.2004.02.004.

[4] Culum Brown, "Fish Pain: An Inconvenient Truth," *Animal Sentience* 1, no. 3 (2016), https://doi.org/10.51291/2377-7478.1069, 32.

[5] João L. Saraiva and Pablo Arechavala-Lopez, "Welfare of Fish—No Longer the Elephant in the Room," *Fishes* 4, no. 3 (2019): 39, https://doi.org/10.3390/fishes4030039.

the world.[6] Considering the share of the aquaculture sector in the Türkiye economy, it is important for Türkiye to be a leader in fish welfare practices.

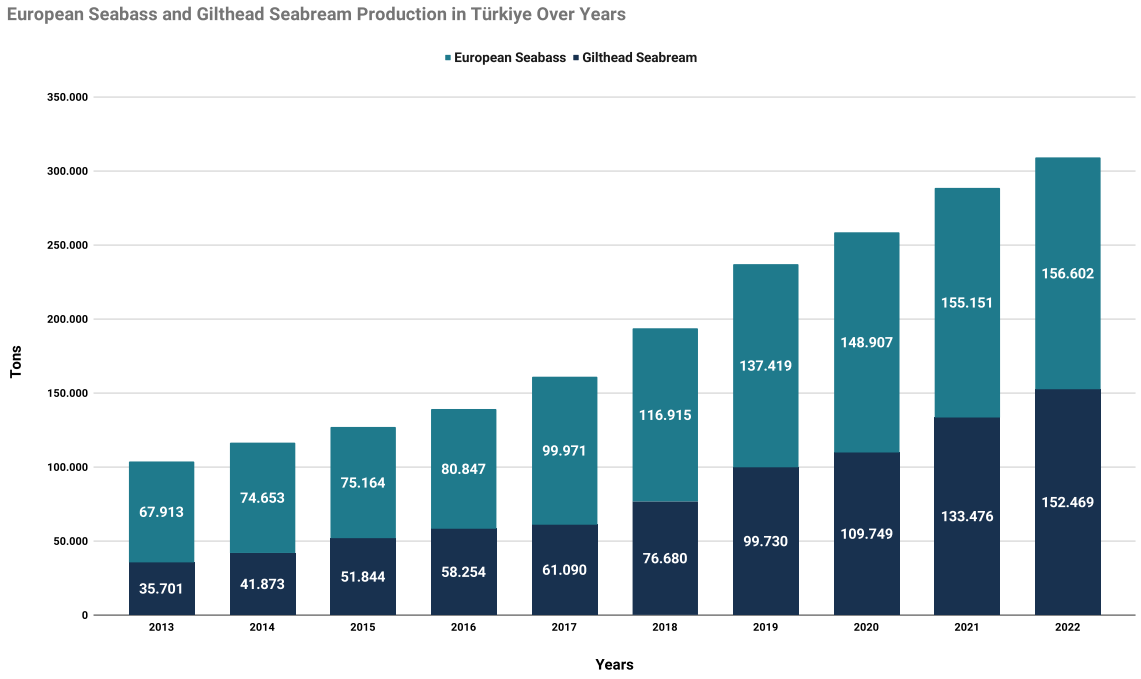


Figure 1: European seabass and gilthead seabream production in Türkiye over the last decade.

Based on the data mentioned above, we predict that the adoption of fish welfare practices and technological developments by the Turkish aquaculture industry will have a great impact on the lives of **billions of fish** every year. Additionally, the aquaculture industry should understand that when the welfare of fish increases, the quality and value of the product also increase. This is one of the rare areas where rational business practices and an ethical perspective demanding welfare standards can be in cooperation. Therefore, another way fish producers can make a difference in the market is by keeping fish welfare standards high.

Hence, we turned our focus to the suffering inflicted on fish by the killing methods commonly used to harvest billions of fish. This report will provide information on what these more humane harvesting practices entail, their applications in Türkiye, a leading producer, and why they represent a step towards the future for companies.

[6] "FAO Fisheries & Aquaculture, “Fishstat Data. Mar. 2023, www.fao.org/fishery/en/statistics/software/fishstatj.

2. Objectives

Currently, the most widely used harvesting method in the European Union and Türkiye is “Live Chilling in Ice Slurry,” which is not acceptable for fish welfare according to existing scientific studies. The main objectives of this report are:

1. To examine the current usage status of "electrical stunning systems" in Türkiye and their effects on fish welfare, which are used in the aquaculture sector in Türkiye, especially in European seabass and gilthead seabream harvesting, and which are aimed to be disseminated as the application that best meets fish welfare according to current research.
2. To demonstrate the status of the Turkish aquaculture sector in fish welfare and evaluate its contribution to global fish welfare standards. While doing all this, to review the practices in Türkiye in terms of market demands and international certification standards.
3. To better elucidate Türkiye's situation and developments in fish welfare and to emphasise the global impact of these developments.

Especially considering the growth trend in Türkiye's aquaculture trade and its influence on international markets, this study highlights the role of the sector at the international level, which makes the current report valuable. Türkiye's seafood exports in 2021 increased by 24% compared to the previous year and reached 1 billion 376 million dollars. This export accounts for 75% and is made to European Union countries.

This study underlines that 59% of aquaculture production in Türkiye comes from aquaculture and that 89.8% of this aquaculture production consists of European seabass (*Dicentrarchus labrax*), gilthead seabream (*Sparus aurata*), and rainbow trout (*Oncorhynchus mykiss*). Therefore, this report inspects the use and impact of "electrical stunning systems," particularly during European seabass and gilthead seabream farming.[7]

Finally, this study was prepared by the Farm Animal Welfare Association's Future For Fish program under the supervision of Prof Dr Deniz Çoban and aims to promote the improvement of fish welfare standards by collaborating with the aquaculture sector.

[7] Çöteli, Fatma T. ÜRÜN RAPORU SU ÜRÜNLERİ, Institute of Agricultural Economics and Policy Development, 2022.

3. Approaches to fish welfare in EU's fish farming sector and targets for electrical stunning

The EU plays an important role with its regulatory frameworks in regulating fish farming and improving fish welfare. This chapter aims to examine the EU's approach to fish welfare and, in particular, the targets it has set for the integration of electrical stunning.

3.1 Fish as Sentient Beings

Fish welfare is increasingly coming to the fore on the EU's policy agenda as a growing number of studies show that fish can feel pain. Fish are recognized by the EU as sentient beings under Article 13 of the Lisbon Treaty on the Functioning of the European Union (TFEU). [8]

The EU regulates that "full regard must be paid to animal welfare requirements" not only in terrestrial agriculture but also in fish farming. [9] Similarly, the EU did not add detailed information to its laws due to little information on fish, and just one paragraph of the report states that the welfare rule principle ('Animals shall be spared any avoidable pain, distress or suffering during their killing and related operations') is applicable to farmed fish[10].

To determine whether a harvest method minimises suffering, it is essential to be able to assess the animal's state of consciousness. This is important both throughout the development of harvesting systems and the use of harvesting machinery and equipment. Additionally, the EU specifically supports scientific studies on fish welfare and funds research showing that fish are sentient.[11, 12, 13]

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[8] Consolidated Version Of Treaty On The Functioning Of The European Union (2012), Article 13, Official Journey of The European Union, C 326/47

[9] Treaty On The Functioning Of The European Union, “Article 13” (2012)

[10] European Union,. COUNCIL REGULATION (EC) No 1099/2009 of 24 September 2009 on the protection of animals at the time of killing. Official Journal of the European Union, 1–30.

[11] European Commission Horizon Research and Innovation Actions, Biosecurity, hygiene, disease prevention and animal welfare in aquaculture (2022), https://www.horizon-europe.gouv.fr/biosecurity-hygiene-disease-prevention-and-animal-welfare-aquaculture-27122

[12] European Research Council, Foundations of Animal Sentience, (2020) https://cordis.europa.eu/project/id/851145

[13] European Commission Horizon Research and Innovation Actions, Curing EU aquaculture by co-creating health and welfare innovations (2022), https://cordis.europa.eu/project/id/101084204

Compared to tetrapods, teleosts have obvious differences in some aspects of brain structure and organisation but are similar to tetrapods in some cognitive aspects, such as sentience. Studies of anatomical, pharmacological, and behavioural studies have revealed that negative affective states such as pain, fear, and stress are experienced in similar ways by fish as by tetrapods. This means that fish have the capacity to suffer, and this should be taken into account in the welfare assessment of farmed fish.[14]

3.2 Regulations on fish welfare

EU's Council Directive 98/58/EC sets the minimum standards for the protection of animals cultivated or kept for agricultural purposes, including fish. Likewise, international organisations have published recommendations and guidelines on fish welfare. In 2005, the European Council adopted a recommendation on the welfare of farmed fish, and in 2008, the World Organization for Animal Health (OIE) decided to publish guidelines for fish welfare. [15, 16]

[14] Chandroo, Duncan, Moccia Can fish suffer? (2004)

[15] Standing Committee of the European Convention for the Protection of Animals Kept for Farming Purposes (T-Ap), Recommendation Concerning Farmed Fish, Adopted by the Standing Committee on 5 December 2005

[16] OIE, Report of the Meeting of the Oie Aquatic Animal Health Standards Commission (2008), https://www.woah.org/fileadmin/Home/eng/Internationa_Standard_Setting/docs/pdf/Oct2008_English_.pdf

3.3 Welfare of fish at the time of killing

EU's Council Regulation No. 1099/2009[17] aims to protect the welfare of animals at the time of killing. The main purpose of the regulation is to protect animals from physical and mental pain, distress, and suffering at the time of slaughter. This regulation establishes certain protection measures and standards that apply to all animal species, including fish. These standards aim to ensure that the slaughter of animals is more humane and guide regulations to prevent animals from suffering unnecessary pain during this process. This regulation clearly states, "Fish shall be spared **any avoidable pain, distress, or suffering during their slaughter.**"

OIE and the European Food Safety Authority (EFSA) unanimously agree that harvesting fish using the live chilling in ice slurry ("Live Chilling Method") method without any procedure that causes loss of consciousness (anaesthesia, electrical stunning, etc.) leads to poor animal welfare standards and, therefore, state that this method should not be used. [18] In addition, EFSA declared in 2009 that alternative systems should be developed immediately, and that electrical stunning is the most promising method for European seabass and gilthead seabream. [19]

The opinion of the Scientific Panel on Animal Health and Welfare (AHAW), organised by the EFSA in 2005, regarding a request from the European Commission on the welfare aspects of stunning and killing of fundamental commercial animal species states: "Member States of the EU should ensure that the slaughter of animals is carried out without fear, anxiety, pain, suffering, and distress by triggering unconsciousness and insensibility (inability to perceive stimuli) through pre-slaughter stunning methods."[20]

The European Commission's study confirmed that "immersed in ice slurry containers" was still widely used as a harvesting method for European

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[17] European Union, "on the protection of animals at the time of killing".

[18] Compassion in Food Business. Tesco driving innovation in humane fish slaughter. www.compassioninfoodbusiness.com/media/7439262/tesco-driving-innovation-in-humane-fish-slaughter.pdf.

[19] EFSA. Scientific Opinion of the Panel on Animal Health and Welfare on a request from the European Commission on welfare aspect of the main systems of stunning and killing of farmed European seabass and seabream. Health (San Francisco) (2009j), 1010, 1–52. https://doi.org/10.2903/j.efsa.2009.1010

[20] EFSA, "Opinion of the Scientific Panel on Animal Health and Welfare (AHAW) on a Request from the Commission Related to Welfare Aspects of the Main Systems of Stunning and Killing the Main Commercial Species of Animals," *EFSA Journal* 2, no. 7 (2004): 45, https://doi.org/10.2903/j.efsa.2004.45.

seabass and gilthead seabream. No other harvesting method has been determined to be widely used. [21]

"Organic" European seabass is produced and marketed in Europe. However, within the scope of Regulation No. 710/2009 on Organic Aquaculture, effective stunning is required in the harvest of these fish, but the failure to comply with this indicates widespread and systematic non-compliance. [22]

As a side note, "farmed" fish are covered very generally in EU legislation, and there are no detailed provisions. This means that the EU is failing to provide adequate protection for the most common 'farm' animals.

3.4 European consumers' demands for fish welfare

A study was conducted by researchers in 2019 to evaluate the impact of the organic label on fish products on the purchasing decisions of German consumers. The study investigated whether an ecolabel on fish products could affect consumers' willingness to pay for the product, especially for products that meet the requirements for fish welfare. The research concluded that German consumers were willing to pay more for organic products that address fish welfare concerns and that this issue was important in Germany. Thus, the researchers noted that fish welfare would be an important consumer demand in the aquaculture industry, with German consumers willing to pay more if welfare standards are met for fish products.[23]

Another study was conducted in five different European countries examining consumer preferences for fish products and the impact of health and eco-labels on products. Researchers conducted a survey with 2,508 participants from England, Germany, Spain, Italy and France. The survey offered consumers the opportunity to choose fish products under different labels. The results show that health and eco labels are effective in consumers' fish product choices. Products with health labels were especially preferred, and consumers were willing to pay extra for these products. These findings highlight the importance of health and eco-

[21] European Parliament Research for Pech Committee, Animal Welfare of Farmed Fish (2023),70-76

[22] Commission Regulation (EC) No 710/2009 of 5 August 2009, amending Regulation (EC) No 889/2008 laying down detailed rules for the implementation of Council Regulation (EC) No 834/2007, as regards laying down detailed rules on organic aquaculture animal and seaweed production, OJ L 204/15.

[23] Isaac Ankamah-Yeboah et al., "The Impact of Animal Welfare and Environmental Information on the Choice of Organic Fish: An Empirical Investigation of German Trout Consumers," *Marine Resource Economics* 34, no. 3 (2019): 247–66, https://doi.org/10.1086/705235..

labeling in the fish products market and demonstrate the value consumers place on these labels.[24]

4. Problem

The problem for fish welfare stems primarily from the fact that throughout history it has been ignored that fish are sentient beings. The fish are numerous and have large populations that are commercially farmed and catched fish. Unlike other farmed animals, there are not yet comprehensive legal protections that specifically address the welfare needs of fish. This has created a gap in the legal framework and made fish vulnerable to potential welfare problems within the aquaculture sector. The traditional assumption that fish do not suffer has resulted in them being left to drown rather than being killed by more humane methods.

At this point, the situation should be evaluated according to the "**Five Freedoms**" approach, which is accepted as a framework that evaluates and promotes animal welfare and includes five basic principles covering the general welfare of animals.[25] These principles are reflected in the aquaculture sector as follows: **raising fish in environments closest to their natural habitats, observing feed quality and species-specific feeding rates, observing stocking density, controlling key water quality indicators, and minimising suffering during slaughter.**[26]

During our thorough research into the Turkish European seabass and gilthead seabream aquaculture sector, we have noted that the stocking density adheres to the recommended welfare conditions. The utilization of automatic/manual feeding systems ensures tailored feeding based on the water temperature of the fish-growing environment, as well as the biome and species of the fish. The minimum handling principle is applied, and efforts are made to safeguard the fish from stress.

In addition, in the processes from breeding to harvest, especially during the grading and transfer stages, which stress the fish, anaesthesia applications and transfer between tanks or to the cage with a fish pump are carried out

[24] Davide Menozzi et al., "Consumers' Preferences and Willingness to Pay for Fish Products with Health and Environmental Labels: Evidence from Five European Countries," *Nutrients* 12, no. 9 (2020): 2650, https://doi.org/10.3390/nu12092650.
[25] David J. Mellor et al., "The 2020 Five Domains Model: Including Human–Animal Interactions in Assessments of Animal Welfare," *Animals* 10, no. 10 (2020): 1870, https://doi.org/10.3390/ani10101870.
[26] Key Animal Welfare Recommendations for Aquaculture. Aquatic Life Institute, 2022.

(Figure 2). However, it has been determined that humane killing methods are rarely used by companies engaged in marine fish farming. **It is stated in many reports and academic studies that commonly used traditional methods for this process, such as the live chilling method, are unacceptable for fish welfare.**[27] Because of the room for improvement in ensuring well-being during harvest, as well as ensuring other well-being conditions in the Five Freedoms approach, the report highlights and focuses on methods to reduce stress and suffering during harvest and encourage their use.

Figure 2: Grading, transfer of fish to offshore net cage facilities, automatic feeding, , and vaccination (Photo: Deniz Çoban)

Acknowledging the significance of fish welfare, given their capacity to feel pain, plays a critical role in advocating for better practices within the industry. Building on the knowledge that fish suffer, this chapter discusses why fish welfare should be considered and why there is a need to reform harvesting practices in the aquaculture sector.

[27] Paul J. Ashley, "Fish Welfare: Current Issues in Aquaculture," *Applied Animal Behaviour Science* 104, no. 3–4 (2007): 199–235, https://doi.org/10.1016/j.applanim.2006.09.001.
. Lluis Tort, Michail A. Pavlidis, and Norman Y. Woo, "Stress and Welfare in Sparid Fishes," *Sparidae*, 2011, 75–94, https://doi.org/10.1002/9781444392210.ch3.

4.1 Fish Feel Pain

The concept of fish welfare is a fairly new concept; the misconception that fish do not have any kind of consciousness or mental ability has been maintained for many years. Current scientific research now strongly suggests that fish are conscious beings with cognitive and learning abilities. [28]

Understanding that fish can feel pain is of great ethical importance. Adequate understanding of this information is very important for legal regulations, consumer preferences, and fish welfare. As examples given below, scientists have conducted important research showing that fish feel stress, fear, and pain. It was only proven in 2003 that rainbow trout have specialised pain receptors (nociceptors), and this evidence led to studies showing that fish feel pain. [29] From this point on, the question was whether the fish feel pain emotionally rather than physically. At this point, a distinction must be made. Pain has two different components: 1- a simple reflex, which does not require cognitive understanding, and 2- long-term reinforcement of this experience. The second component means remembering that the context that causes pain is dangerous and staying away from it. This system requires cognitive engagement to function. Without cognitive engagement, if a person's hand were to be burned, they would continue to place their hand on the source of pain repeatedly because the emotional response to painful stimuli serves as a reinforcement to encourage learning from such experiences. [30] Animals capable of feeling pain demonstrate long-term reinforcement by avoiding the source that causes pain. [31]

Research 1:

In one study, researchers found that rainbow trout injected with acetic acid in their lips started to breathe more quickly, rocked back and forth on the bottom of the tank, rubbed their lips against the side of the tank, and took twice as long to return to feeding as usual. The researchers observed that

[28] Culum Brown, "Fish Intelligence, Sentience and Ethics," *Animal Cognition* 18, no. 1 (2014): 1–17, https://doi.org/10.1007/s10071-014-0761-0.

[29] L. U. Sneddon, V. A. Braithwaite, and M. J. Gentle, "Do Fishes Have Nociceptors? Evidence for the Evolution of a Vertebrate Sensory System," Proceedings of the Royal Society of London. Series B: Biological Sciences 270, no. 1520 (2003): 1115–21, https://doi.org/10.1098/rspb.2003.2349.

[30] Culum Brown and Catherine Dorey, "Pain and Emotion in Fishes – Fish Welfare Implications for Fisheries and Aquaculture," *Animal Studies Journal* 8, no. 2 (2019): 175–201, https://doi.org/10.14453/asj.v8i2.12.

[31] Edgar T. Walters, "Defining Pain and Painful Sentience in Animals," *Animal Sentience* 3, no. 21 (2018), https://doi.org/10.51291/2377-7478.1360.

these behaviours stopped when the painkiller morphine was administered. Analgesics such as morphine relieve pain but do not eliminate the source of the pain. This shows that the behaviour of fish reflects not only their physiological state but also their mental state. If the fish had merely a reflexive response to acid and were unable to consciously experience pain, then morphine should not have made a difference. [32]

Research 2:

In this case study, rainbow trout are initially indifferent to different areas of the aquarium. However, fish that encounter a slight shock when entering a certain area quickly learn to avoid that area. Similarly, when positive rewards such as food or other fish are added to a separate area, rainbow trout change their preferences to access these rewards. Interestingly, however, when shock and rewards coincide in the same area, fish are willing to risk shock in exchange for access to food or mates. This behaviour suggests that fish are willing to endure pain in exchange for access to valuable resources.[33]

The common point of all these studies is to demonstrate that the response of fish to painful stimuli is not merely a reflexive behaviour but, on the contrary, involves long-term cognitive interaction with pain. Therefore, preventing the painful process that fish experience during the harvesting process is crucial for fish welfare.

Moreover, from the producer's perspective, this is also very important to improve the quality of the fish during and after harvest. **To put it more clearly, minimising pre-harvest stress and using humane harvesting methods increases product quality in many areas, especially shelf life.** [34] This subject will be examined in more detail in the following chapters.

4.2 Harvest Methods

Harvesting in offshore net cages involves crowding the fish in the net, placing them into harvest tanks with a fish pump/scoop net, and then transporting them to the onshore processing facility as soon as possible

[32] Lynne U Sneddon, Victoria A Braithwaite, and Michael J Gentle, "Novel Object Test: Examining Nociception and Fear in the Rainbow Trout," *The Journal of Pain* 4, no. 8 (2003): 431–40, https://doi.org/10.1067/s1526-5900(03)00717-x..

[33] Rebecca Dunlop, Sarah Millsopp, and Peter Laming, "Avoidance Learning in Goldfish (Carassius Auratus) and Trout (Oncorhynchus Mykiss) and Implications for Pain Perception," *Applied Animal Behaviour Science* 97, no. 2–4 (2006): 255–71, https://doi.org/10.1016/j.applanim.2005.06.018.

[34] B. M. Poli et al., "Fish Welfare and Quality as Affected by Pre-Slaughter and Slaughter Management," *Aquaculture International* 13, no. 1–2 (2005): 29–49, https://doi.org/10.1007/s10499-004-9035-1.

(Figure 3). [35] The most frequently used method in the EU and Türkiye is live chilling method. [36] The welfare of fish during harvest is a critical issue that affects the quality of the final product and raises ethical questions. The stress levels of fish can be determined by criteria such as cortisol levels. Pre-harvest stunning and slaughter methods play an important role in fish welfare and product quality. **Traditional harvesting methods and methods such as live chilling method can cause fish to experience stress for a long time before death.** In contrast, more humane harvesting methods, such as electrical stunning, aim to minimise stress and also increase consumer satisfaction.

Figure 3: Harvesting with a scoop net in an offshore cage system (Photo: Deniz Çoban)

4.2.1 What Does Fish Welfare Mean During Slaughter?

From an animal welfare perspective, if the pain suffered by the animal is reduced as much as possible before slaughter, we can refer to a more humane slaughter here. Loss of consciousness is necessary before death to reduce the animal's suffering during death. The European Commission defines stunning as "any intentionally induced process, including any process resulting in immediate death, that causes unconsciousness and insensitivity to pain without causing pain."[37]

Consciousness can be thought of as awareness of the surroundings and of oneself; here, unconsciousness means unresponsiveness.[38] Ideally, loss of consciousness should occur immediately (i.e., within a second). [39] If the loss

[35] Ashley, "Current issues in aquaculture"

[36] European Parliament Pech Committee, Animal Welfare of Farmed Fish, 70-76

[37] European Union, on the protection of animals at the time of killing

[38] E. Lambooij et al., "Percussion and Electrical Stunning of Atlantic Salmon (Salmo Salar) after Dewatering and Subsequent Effect on Brain and Heart Activities," *Aquaculture* 300, no. 1–4 (2010): 107–12, https://doi.org/10.1016/j.aquaculture.2009.12.022.

[39] EFSA "Welfare Aspects of the Main Systems of Stunning and Killing" (2004)

of consciousness is not permanent, an alternative procedure must be used to kill the fish and prevent it from regaining consciousness.[40]

Abnormal behaviours such as trying to escape, breathing at the water's surface, or keeping the mouth and operculum closed indicate that the loss of consciousness never occurred or that consciousness is regained after a while. However, the lack of these behaviours does not necessarily indicate a successful attainment of unconsciousness. [41]

There is a growing awareness in the aquaculture industry that harvesting should take place in more humane conditions, fish should lose consciousness immediately before harvest, and the loss of consciousness should continue until death.[42]

In summary, to talk about a more humane method of killing:
1- There must be loss of consciousness: **the necessary and correct shocking** device must be used to cause rapid and irreversible loss of consciousness,
2- **Making sure that consciousness does not return before death**: Ocular movements must be controlled, and abnormal movements such as escaping movements and breathing on water must not occur[43].

4.2.2 Live Chilling Method

The live chilling method involves immersing fish for harvest in ice slurry tanks for several minutes to several hours. Death is the result of the cessation of blood flow, which leads to the cessation of oxygen supply to the brain (hypoxia and ischemia). Studies show that it takes approximately between five minutes to forty minutes for the fish to lose consciousness if

[40] OIE, essay, in *Aquatic Animal Health Code*, Twenty-second edition (Paris, France: World Organisation for Animal Health, 2019), 138–41.
[41] E Lambooij et al., "Welfare Aspects of Live Chilling and Freezing of Farmed Eel (Anguilla Anguilla L.): Neurological and Behavioural Assessment," *Aquaculture* 210, no. 1–4 (2002): 159–69, https://doi.org/10.1016/s0044-8486(02)00050-9.
[42] Jeroen Brijs et al., "The Final Countdown: Continuous Physiological Welfare Evaluation of Farmed Fish during Common Aquaculture Practices before and during Harvest," *Aquaculture* 495 (2018): 903–11, https://doi.org/10.1016/j.aquaculture.2018.06.081.
[43] CIWF, "The Welfare Of Farmed Fish During Slaughter In The European Union," 2018, https://www.ciwf.org.uk/media/7434891/ciwf-2018-report__the-welfare-of-farmed-fish-during-slaughter-in-the-eu.pdf

this method is used, so this method causes prolonged stress before death.[44,45,46,47]

For example, in one study, it was observed that after being immersed in ice using the live chilling method, the sea bass became motionless in three minutes, yet eleven minutes later, it still responded to external stimuli.[48]. Various studies report that European seabass and gilthead seabream remain conscious, when used the live chilling method, for periods ranging from 5 to 40 minutes. [49, 50, 51] It has been observed that gilthead seabream harvested using the live chilling method "attempt to escape by jumping and swimming vigorously."[52] EFSA defines the live chilling method as an immobilisation method, not a stunning method, as it does not cause loss of consciousness.[53]

In addition, in excessive temperature differences, bleeding occurs due to convulsions, which creates problems in terms of both harvest quality and hygiene (Figure 4).

[44] Hans Van De Vis et al., "Is Humane Slaughter of Fish Possible for Industry?," *Aquaculture Research* 34, no. 3 (2003): 211–20, https://doi.org/10.1046/j.1365-2109.2003.00804.x.

[45] A. Huidobro, R. Mendes, and M. Nunes, "Slaughtering of Gilthead Seabream (Sparus Aurata) in Liquid Ice: Influence on Fish Quality," *European Food Research and Technology* 213, no. 4–5 (2001): 267–72, https://doi.org/10.1007/s002170100378.

[46] Grigory V. Merkin et al., "Effect of Pre-Slaughter Procedures on Stress Responses and Some Quality Parameters in Sea-Farmed Rainbow Trout (Oncorhynchus Mykiss)," *Aquaculture* 309, no. 1–4 (2010): 231–35, https://doi.org/10.1016/j.aquaculture.2010.08.025.

[47] Van De Vis et al., "Is Humane Slaughter of Fish Possible for Industry?"

[48] Giulia Zampacavallo et al., "Evaluation of Different Methods of Stunning/Killing European seabass (Dicentrarchus Labrax) by Tissue Stress/Quality Indicators," *Journal of Food Science and Technology* 52, no. 5 (2014): 2585–97, https://doi.org/10.1007/s13197-014-1324-8.

[49] Van De Vis et al., "Is Humane Slaughter of Fish Possible for Industry?"

[50] M. Bagni et al., "Pre-Slaughter Crowding Stress and Killing Procedures Affecting Quality and Welfare in European seabass (Dicentrarchus Labrax) and Seabream (Sparus Aurata)," *Aquaculture* 263, no. 1–4 (2007): 52–60, https://doi.org/10.1016/j.aquaculture.2006.07.049.

[51] A. Giuffrida et al., "Influence of Slaughtering Method on Some Aspects of Quality of Gilthead Seabream and Smoked Rainbow Trout," *Veterinary Research Communications* 31, no. 4 (2007): 437–46, https://doi.org/10.1007/s11259-007-3431-8.

[52] George Vardanis et al., "The Use of Biochemical, Sensorial and Chromaticity Attributes as Indicators of Postmortem Changes in Commercial-Size, Cultured Red Porgy Pagrus Pagrus, Stored on Ice," *Aquaculture Research* 42, no. 3 (2010): 341–50, https://doi.org/10.1111/j.1365-2109.2010.02628.x.

[53] EFSA, "Opinion of the Scientific Panel on Animal Health and Welfare (AHAW) on a Request from the Commission Related to Welfare Aspects of the Main Systems of Stunning and Killing the Main Commercial Species of Animals," *EFSA Journal* 2, no. 7 (2004): 45, https://doi.org/10.2903/j.efsa.2004.45.

Figure 4: Bleeding at harvest (Photo: Deniz Çoban)

Slaughtering fish using the live chilling method without stunning the fish prior to slaughter is absolutely UNACCEPTABLE in terms of fish welfare and should be discontinued.

Instead of the live chilling method, which causes stress and negatively affects fish quality, there is now a system that is more accessible and, when used correctly, minimises pain and provides a more humane harvest: Electrical stunning system.

4.2.3 Pre-Slaughter process

Most studies focus on stress during slaughter and often overlook the pre-slaughter period. Although it varies depending on the fish species, if possible, the entire net cage should be harvested, and if the entire net cage is not harvested, the process of crowding the net should be done with as little stress as possible. As soon as the harvest is finished, the net in the net cage should be restored. Rough handling and repeated capture of fish during crowding causes increased stress, as evidenced by changes in high cortisol and haematocrit levels. Failure to tolerate this stress will likely lead to an increase in disease. Crowding and harvesting methods applied before

slaughter cause irreversible damage to body tissues and especially the skin, such as falling off of scales. Lost scales and mucus cause damage to the fish's external defence mechanism. Therefore, it is important to use pre-slaughter and during-slaughter techniques that will minimise stress responses and physical activity.[54]

Carrying out pre-slaughter procedures without causing pain, fear, or stress not only makes a difference in terms of fish welfare standards but also ensures less damage to the fish's body. Fish are often crowded to high densities just before harvest. This procedure should be done **as soon as possible** to avoid unnecessary pain. Increased muscle activity during harvest depletes energy reserves and leads to increased lactic acid levels and decreased pH, leading to rapid rigor mortis and ultimately adversely affecting the viability of tissues in the fish body. Pre-slaughter stress can also lead to the oxidation of polyunsaturated fatty acids, resulting in the production of reactive oxygen metabolites that cause serious changes in nucleic acids, proteins, and lipids. As a result, the nutritional value of the fish after harvest and the vitality of the tissues decreases due to the loss of polyunsaturated fatty acids.[55]

Figure 5: Pre-harvest crowding. (photo: Deniz Çoban)

UK-based supermarket chain Tesco has implemented a protocol to improve fish welfare during crowding, setting welfare standards defined as good, acceptable, and unacceptable. Accordingly, it is recommended to crowd the fish for a maximum of two hours and closely monitor the oxygen levels every fifteen minutes to ensure the oxygen saturation level is above eighty percent. It is underlined that if the fish show signs of stress or the oxygen saturation level drops below eighty percent, the nets should be released and more space should be provided for the fish.[56]

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[54] Ignacio de la Rosa, Pedro L. Castro, and Rafael Ginés, "Twenty Years of Research in Seabass and Seabream Welfare during Slaughter," *Animals* 11, no. 8 (2021): 2164, https://doi.org/10.3390/ani11082164.

[55] Bagni et al., "Pre-Slaughter Procedures Affecting Quality and Welfare"

[56] Compassion in Food Business. "Tesco innovation in fish slaughter"

4.2.4 Electrical Stunning System

Electrical stunning is one of the most studied stunning/harvest methods in various fish species. This method involves administering an electric current to the water or directly to the fish until complete loss of consciousness. It is considered more humane because it is designed to cause rapid loss of consciousness and ultimately complete loss of brain functions. It ensures minimising or eliminating anxiety, pain, and distress at the time of killing. Additionally, it is necessary to ensure that the fish does not regain consciousness before death.[57]

After the fish enters the electrical stunning system, it loses consciousness but regains consciousness after a while. For this reason, after passing through the electrical stunning system, another stage is required for the fish to die. For European seabass, this involves ending its life in a way that prevents it from regaining consciousness after effective electrical stunning, typically through the use of the live chilling method. [58] The fish are rendered unconscious by exposure to an electric current before being placed in an ice slurry tank for harvesting. The time it takes to regain consciousness varies by method, but it is crucial for a more humane harvest that fish quickly become unconscious after exposure to electric current and remain unconscious until death occurs. This can range from less than a minute to over twenty minutes (when more traditional methods are used), depending on the approach used and the type of fish. [59]

In light of all this information, harvesting using only live chilling method is not acceptable from a fish welfare perspective. Current research recommends the use of species-specific electrical stunning for a more humane harvest, with fish welfare in mind. [60] In addition, this system is among the systems recommended to be used and developed by OIE for fish welfare.[61]

The purpose of making the fish unconscious with an electrical stunning machine is to minimise unnecessary stress and pain. Consumers are

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[57] de la Rosa and Castro, "Twenty Years of Research"

[58] Bert Lambooij et al., "Evaluation of Electrical Stunning of European seabass (Dicentrarchus Labrax) in Seawater and Killing by Chilling: Welfare Aspects, Product Quality and Possibilities for Implementation," *Aquaculture Research* 39, no. 1 (2007): 50–58, https://doi.org/10.1111/j.1365-2109.2007.01860.x.

[59] de la Rosa and Castro, "Twenty Years of Research"

[60] Compassion In Food Business, "Improving the welfare of European European seabass and gilthead seabream at slaughter," https://www.compassioninfoodbusiness.com/media/7436994/improving-the-welfare-of-sea-bream-and-european-sea-bass-at-slaughter.pdf

[61] OIE, "*Aquatic Animal Health Code*"

increasingly demanding the high welfare standards for fish throughout all processes, including harvest. As a result, the fish farming industry faces the challenge of proving its commitment to more ethical and humane practices.[62]

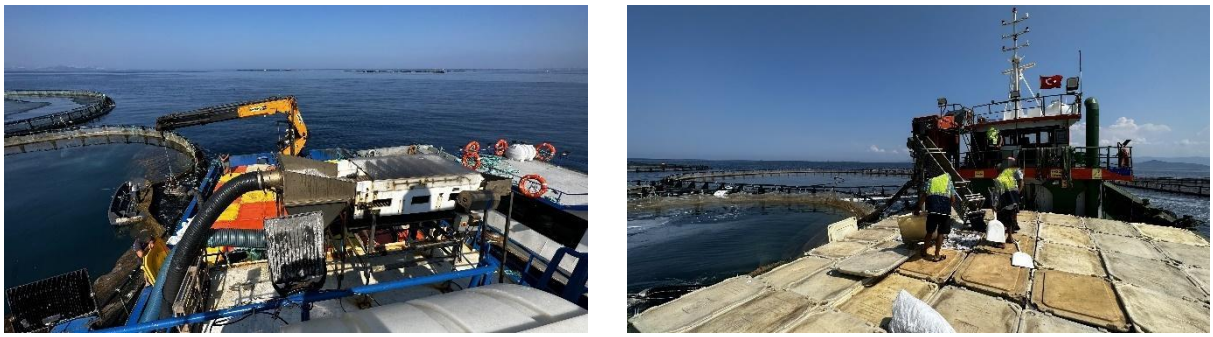

Figure 6: Harvesting by electrical stunning in an offshore net cage system (Photo: Deniz Çoban).

Advantages of The Electrical Stunning System Compared to The Live Chilling Method:

The choice of harvest method in aquaculture can significantly affect fish welfare, product quality, and marketability. This chapter includes the literature review on the subject and information learned from the field.

- Regardless of the method used to harvest fish, there is consensus that a correct and effective stunning procedure will reduce damage to the fish's body tissues. A correct and efficient stunning procedure will reduce soft tissue appearance, disintegration, bruising, and scale loss and increase shelf life compared to traditional harvesting methods. The electrical stunning system also improves the working conditions of staff and reduces the possibility of recurrent injuries. [63]
- In one study, pH values in European seabass slaughtered by the live chilling method were observed to be significantly higher on days 1, 2, 8, and 10 compared to fish stunned with electricity. [64] In general, excessively high pH levels in fish can change the texture, appearance, and shelf life of fish, making it less attractive to consumers. Quality control measures aim to maintain pH levels within an acceptable range to ensure that fish products meet consumer expectations.
- According to one study, electrical stunning accelerated the pattern of onset and resolution of rigor mortis in European seabass when

[62] de la Rosa and Castro, “Twenty Years of Research”

[63] Holymard, Nicki. "Fish Producers Benefit from Humane Slaughter Techniques." Global Seafood Alliance, 10 Apr. 2017, www.globalseafood.org/advocate/fish-producers-benefit-humane-slaughter-techniques/.

[64] Lambooij et al., “Evaluation of Electrical Stunning of European seabass”

compared to immersion in ice slurry. Potential benefits of faster onset and resolution of rigor mortis include: Faster onset of rigor mortis can be viewed as an indicator of freshness. This is because it can indicate a faster post-mortem condition. A faster resolution of rigor mortis may cause the fish's body tissues to become softer.[65]

- A study on rainbow trout shows that the electrical stunning system is associated with lower stress levels, evident from blood parameters, and better retention of fish shape during storage. Higher stress can negatively impact customer satisfaction.[66]
- Less staff is needed, so less labour is required to operate. It provides better organisation and occupational safety on harvest ships. [67]

Figure 7: Gilthead seabream harvested with electrical stunning system (Photo: Deniz Kıraç Uncu).

- Based on information obtained from the field, the live chilling method causes bleeding in the gills and increases blood microbial activity, negatively affecting hygiene. During the process from harvest to

[65] de la Rosa, I.; Castro, P.L.; Ginés, R. Twenty Years of Research in Seabass and Seabream Welfare during Slaughter. Animals 2021, 11, 2164. https://doi.org/10.3390/ani11082164

[66] Anna Concollato et al., "Effects of Stunning/Slaughtering Methods in Rainbow Trout (Oncorhynchus Mykiss) from Death until Rigor Mortis Resolution," *Aquaculture* 464 (2016): 74–79, https://doi.org/10.1016/j.aquaculture.2016.06.009.

[67] This information was obtained from interviews with producers conducted for this report.

processing, microbial activity spreads through blood and similar channels. Due to the nature of fish, the disease in their intestines carries a higher risk of transmission through blood. When using the electrical stunning method, the fish does not struggle and does not experience injury or bleeding, so the harvest tank is kept sterile.

Figure 8: The image on the left shows fish harvested with the electrical stunning system, the image on the right shows fish harvested with live chilling method. (photo: Deniz Kıraç Uncu)

It should be kept in mind that the post-harvest qualities of fish are affected by various factors, such as pre-slaughter stress levels, pH changes in the carcass, and post-mortem processing. Current scientific studies show that more research is needed to further investigate and understand the effects of electrical stunning on European seabass and gilthead seabream. More funding and research is needed on this topic. In this regard, the research findings in the report may vary in the future.

4.2.5 Conclusion

In conclusion, the use of more humane harvesting methods in the aquaculture industry is becoming increasingly important for fish welfare, customer satisfaction, and market competitiveness. Regardless of the method used, it is widely accepted that the use of correct and effective stunning reduces damage to fish tissue. It is observed that the electrical stunning machine reduces the disintegration, bruising, and scale loss in the fish, ultimately extending the shelf life. In addition, the electrical stunning machine improves the working conditions of personnel and reduces the risk of recurrent injuries.

Research has demonstrated that electrical stunning accelerates the onset and resolution of rigor mortis in fish compared to live chilling method. This

shows that the fish enters the post-mortem state faster, which means its body tissues are softer, making it more attractive to the consumer.

The advantages of electrical stunning, as supported by scientific research, are mentioned above. The following chapters of the report will cover, in more depth, the information obtained from the field and the benefits of using this method.

In summary, opting for more humane and efficient harvesting practices not only maintains fish welfare standards but also responds to the high-quality demand. Adopting more responsible and humane practices will continue to be an important agenda item in the aquaculture sector.

4.3 Relevant Legislation

Legal regulations of EU countries regarding fish welfare are covered in Chapter 3. This chapter includes the regulations in the Turkish legal system. To ensure the welfare of fish farmed in aquaculture facilities and to comply with the EU, the **"Circular on the Welfare of Farmed Fish" No. 2018/3 (“Circular”)** was introduced on 16.11.2018 by the Turkish Ministry of Agriculture and Forestry, General Directorate of Fisheries and Aquaculture, based on paragraph J of the twenty-first article of the "Aquaculture Regulation" and considering the "European Union Council Directive Concerning the Protection of Animals Kept for Farming Purposes" and "Recommendations of the Standing Committee of the European Convention for the Protection of Animals Kept for Farming Purposes." The Circular is one of the few legal regulations on this subject globally.

Harvesting is regulated in Article 11 of the Circular in question:

ARTICLE-11 Harvest
1) Maximum importance shall be attached to harvesting the fish with the least stress possible.
2) If the harvest tanks are of standard sizes, 300-350 kg of fish can be placed in one tank.
3) The fish to be harvested shall be left hungry for at least two days.
4) The personnel responsible for harvesting shall be fully equipped.

The section of the Circular titled "Harvest ARTICLE-11" includes some standards for harvesting in fish farming facilities and protecting fish welfare. Electrical stunning systems meet the standards stipulated in the circular as follows:

Harvesting Process and Fish Welfare: It is stated in this section that maximum importance should be given to harvesting the fish with the least stress possible. Electrical stunning allows fish to lose consciousness quickly, ensuring less stress and pain than traditional harvesting methods.

Harvest Tanks: Electrical stunning makes it easy to place harvested fish into standard-size tanks. This ensures orderly storage and transport of fish.

Personnel Equipment: The circular states that the personnel responsible for the harvesting process must be fully equipped. Personnel training and appropriate equipment are important for the use of electrical stunning. As mentioned above, electrical stunning improves the working conditions of personnel and reduces the risk of recurrent injuries.

The use of electrical stunning meets the conditions specified in the circular during fish harvest, on the contrary, the live chilling method is not compatible with the circular as it causes intense stress to the fish during the harvest process. Electrical stunning systems comply with such standards by increasing fish welfare and improving product quality.

5.Methodology

To obtain data on the use of the electrical stunning system in aquaculture companies in Türkiye, we carried out in-depth face-to-face/online surveys on production methods and animal welfare with key stakeholders of the Turkish aquaculture industry, including CEOs, Quality Managers, Production Managers, and Sales Managers. The survey consists of two parts and thirty-two open-ended questions, covering production methods and approaches to animal welfare. Interviews were conducted with leading aquaculture companies, such as Abalıoğlu Balık ve Gıda Ürünleri A.Ş., Agromey Gıda ve Yem A.Ş., Çamlı Yem Besicilik Sanayi ve Ticaret A.Ş., Gümüşdoğa Su Ürünleri A.Ş., Kılıç Deniz A.Ş., More Su Ürünleri A.Ş., Noordzee Su Ürünleri A.Ş., Sürsan Su Ürünleri A.Ş., Tümay Balıkçılık Gıda A.Ş., and Uğurlu Balık (LuckyFish) Üretim San Tic. A.Ş. The companies we interviewed for our research account for 76% of the total European seabass and gilthead seabream production in Türkiye.

6.Findings

After conducting interviews with producers and visiting production sites, we observed that there is room for improvements in achieving a less painful harvest, considered one of the five freedoms, based on the fundamental indicators of fish welfare. [68] Industry representatives responded to our questions with great interest. Industry representatives have responded to our questions in a highly informative manner. These companies generally state that they highly respect fish welfare and emphasise their commitment to causing minimal stress, attention to fish diseases, and careful consideration of feeding time and rates. In addition, all producers stated that their stocking density rates were below 15 kg/m3. The data we obtained from our interviews with aquaculture companies is as follows.

[68] Aquatic Life Institute. "Key Animal Welfare Recommendations for Aquaculture." Mar. 2022.
1- Closeness to the natural habitat,
2- Stocking density,
3- Feed quality and ratio,
4- Water quality,
5- Ensuring loss of consciousness during harvest

6.1 Harvest Methods

Popular Harvest Techniques: Participating companies primarily use the live chilling method or electrical stunning systems to harvest gilthead seabream and European seabass.

Prevalence of Electrical Stunning: Remarkably, nine out of ten companies interviewed possess at least one electrical stunning system.

Variability of Electrical Stunning Use: Based on market demands, these companies have different preferences in using electrical stunning for harvesting.

Effect on Price: Producers using electrical stunning stated that using this system did not increase the sales price of their products in the domestic market or the foreign market.

6.2 Using the Electrical Stunning System

Electrical Stunning Usage Percentage: 40% of participating producers use electrical stunning on more than 95% of their harvest. Some producers prefer the electrical stunning system only for gilthead seabream harvesting due to its ease of use. According to the information provided by the producers, European seabasses get stuck in fish pumps due to their body shape and this causes haemorrhages on their skin; that's why electrical stunning is less preferred.

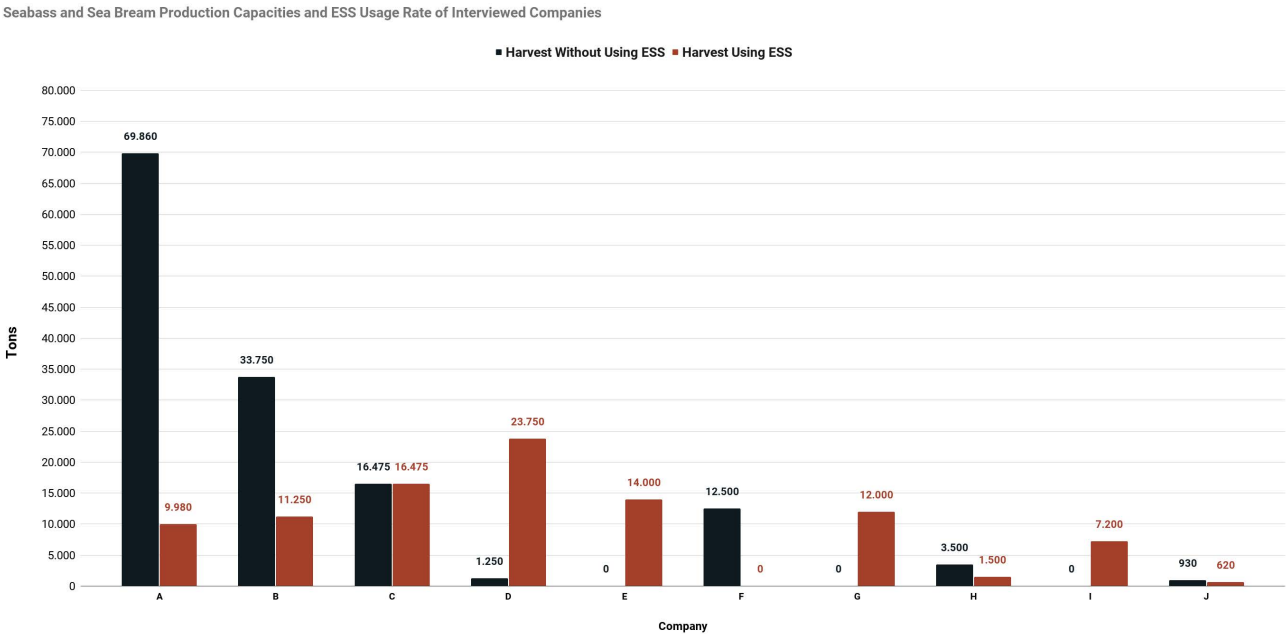

Figure 9: Production capacities and electrical stunning usage amounts of the interviewed companies

Representation in the Industry: Participating companies represent 76% of the total European seabass and gilthead seabream production in Türkiye, which emphasises the importance of our findings in terms of generalizability.

Widespread Use of Electrical Stunning: 90% of the companies we interviewed have at least one electrical stunning machine and use it at different rates in some of their harvesting activities.

Scope of Electrical Stunning Application: Approximately 40% of those using electrical stunning system reported using this technology for most of their harvesting processes (more than 95%). Some customers request a live video connection during harvest, install cameras on boats, or visit the farm when they request the electrical stunning system. These inspections occur at regular intervals. Whether or not fish deaths occur in electrical stunning machines during harvest is also among the issues inspected.

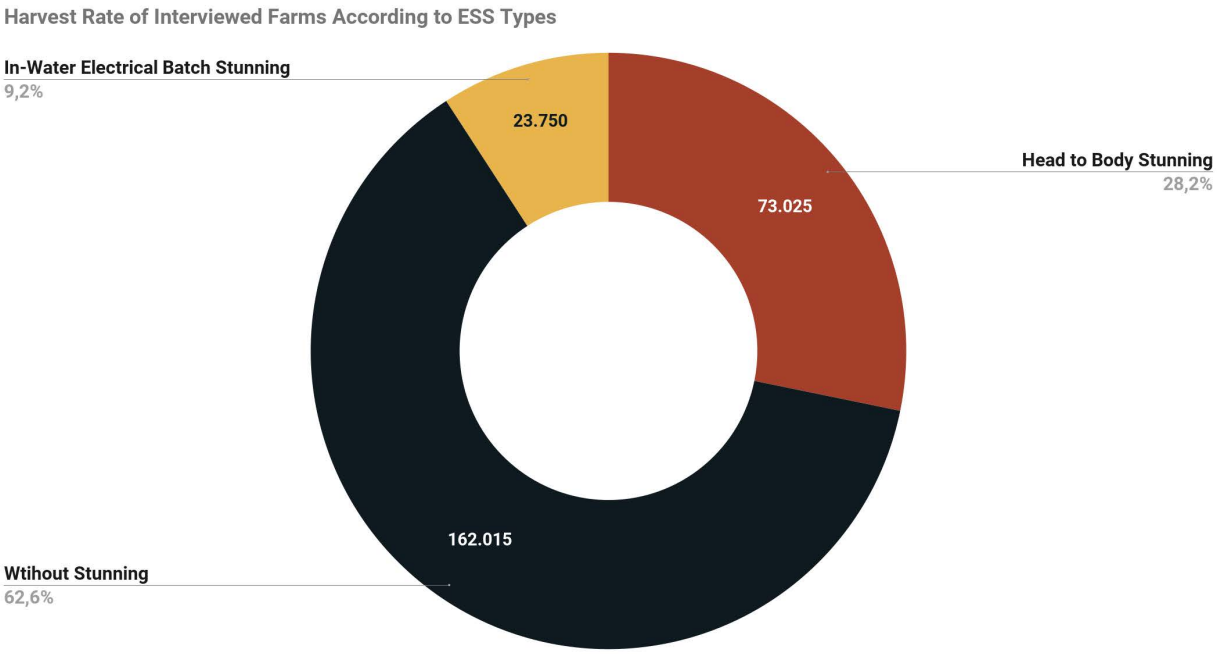

Figure 10: The interviewed farms' usage percentage of electrical stunning types

Perception of Electrical Stunning: A significant proportion (60%) of electrical stunning users report that the system works faster than live chilling method. However, some companies stated that it is not possible to use the electrical stunning system in stormy weather because the boats rock, so they use the live chilling method. All interviewed companies stated that using electrical stunning did not have a positive impact on the prices of their products.

6.3 Current Situation in Fish Welfare

Focus on Fish Welfare: All participating producers demonstrated a strong commitment to fish welfare and reported a range of initiatives for fish welfare, such as training sessions and meetings on this topic. They also declared that they were trying to adhere to fish welfare standards. In this context, they stated that they paid and would continue to pay maximum attention to issues such as stocking density, feeding systems, disease, and mortality rates.

Survival Rates and Feed Conversion Ratio (FCR): As a result of these practices, it is observed that the mortality rates of fish in net cages vary between 10 and 15 percent. Additionally, FCR varies between 1:1 and 1:1.5 depending on the type of fish cultured.

6.4 Challenges and Disadvantages of Electrical Stunning

Various disadvantages and challenges with electrical stunning reported by companies include:

- The most important problem is the installation of the electrical stunning machine on the harvest boat,
- In cases when the weather is windy and waves are high, not enough fish can reach the electrical stunning system from the fish pump,
- Product prices are not increased due to the use of electrical stunning,
- Limited market demand for fish harvested by electrical stunning,
- Restrictions on the size of boats for electrical stunning installations,
- Variability in harvest time; the use of electrical stunning for certain machines may result in slower harvests.
- Since it is a mechanical system, malfunctions may occur,
- Some companies may experience delays in the supply of spare parts, for some companies, the delivery of spare parts may take 8-12 weeks,
- In bad weather conditions, some companies may experience difficulties in using electrical stunning fish pumps,
- Blind spots may occur as a result of some harvest tanks not being accessible due to problems in the installation of the system on the boat.

Based on the information obtained from the producers, if a rapid harvest is made with electrical stunning, the fish may not experience a complete loss of consciousness as the shocking process occurs quickly, and if this occurs, bloody water is observed in the tank, as in the live chilling method. For this reason, they reported that in electrical stunning, pump suction, and belt speed should be adjusted according to the size of the fish to be harvested.

All producers stated that the disadvantages listed above could be solved either by working with electrical stunning system manufacturers or by creating solutions within themselves, and if the device was further improved, it would be more commonly used.

With the use of electrical stunning, the harvest boat becomes more specialised. The electrical stunning system should be positioned slightly above the deck where tanks are placed (Figure 11). This may require moving the tank up on its legs to create a suitable area for electrical stunning.

Additionally, depending on the size of the boat, it may be necessary to allocate a special area above or behind the cabin to install the electrical stunning system. This does not prevent the boat from being used for other tasks but rather makes it designed for the more specific purpose of harvesting operations. For example, when one boat breaks down, it is not possible to immediately transfer the electrical stunning to the other boat and continue harvesting. In such cases, they may use the live chilling method, or if a spare boat is available, its electrical stunning can be used.

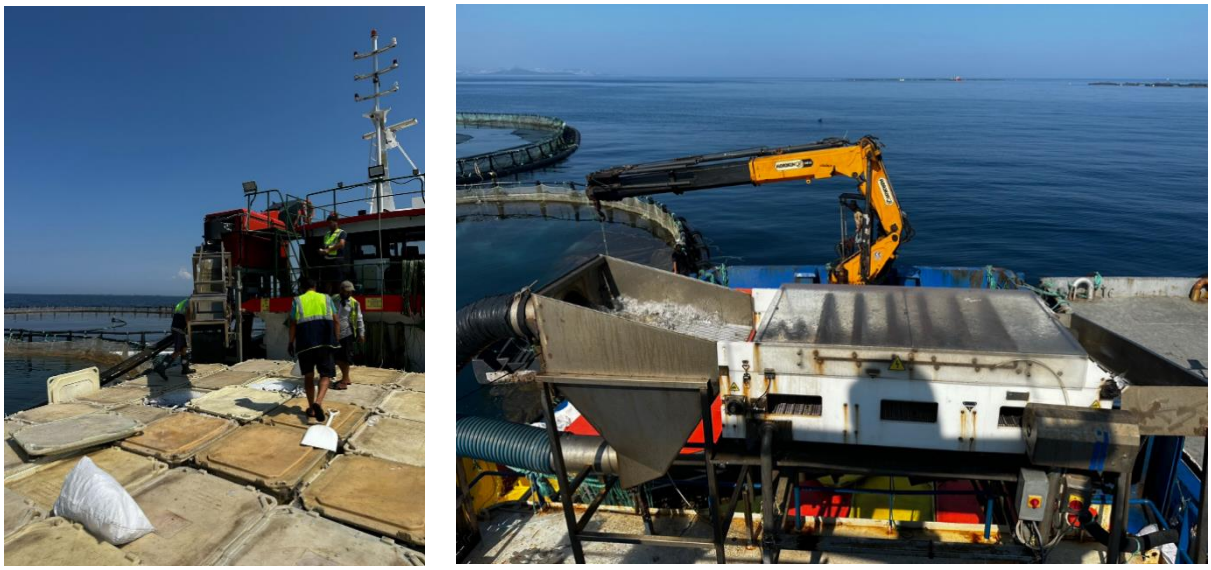

Figure 11: Electrical stunning system installed according to boat sizes. (Photo: Deniz Kıraç Uncu)

According to important information from one producer, netting fish in small cages and then harvesting them with a scooping net is the preferred method. Among their reasons for not using fish pumps is the possibility of fish pumps harming the fish (scaling, skin rash, etc.). It has been emphasised that harvesting with a fish pump may harm the fish, especially depending on the size of the fish, and that this method is not suitable, especially for large fish.

Here is a valuable insight we gained from our interviews with producers regarding the disadvantages of electrical stunning systems: "Each new piece of equipment increases operating costs and creates maintenance requirements. But ultimately, it provides more benefits to the producer."

6.5 Factors Encouraging the Use of Electrical Stunning

Some factors that encourage the use of electrical stunning, according to producers, are as follows:

- Customer demands, especially from countries such as the United Kingdom and the Netherlands,
- Electrical stunning increases product quality and shelf life,
- Desire to follow industry trends,
- Ease of use,
- According to some producers, the fish pump is easier to control than the scooping net in bad weather conditions,
- It is a faster procedure than the live chilling method, according to some producers,
- If the harvest is done correctly, the fish will not struggle in the water and will not lose scales as observed with the live chilling method; therefore, when the electrical stunning system is used, the fish will have a brighter appearance,
- Increased customer satisfaction,
- Decrease in customer complaints,

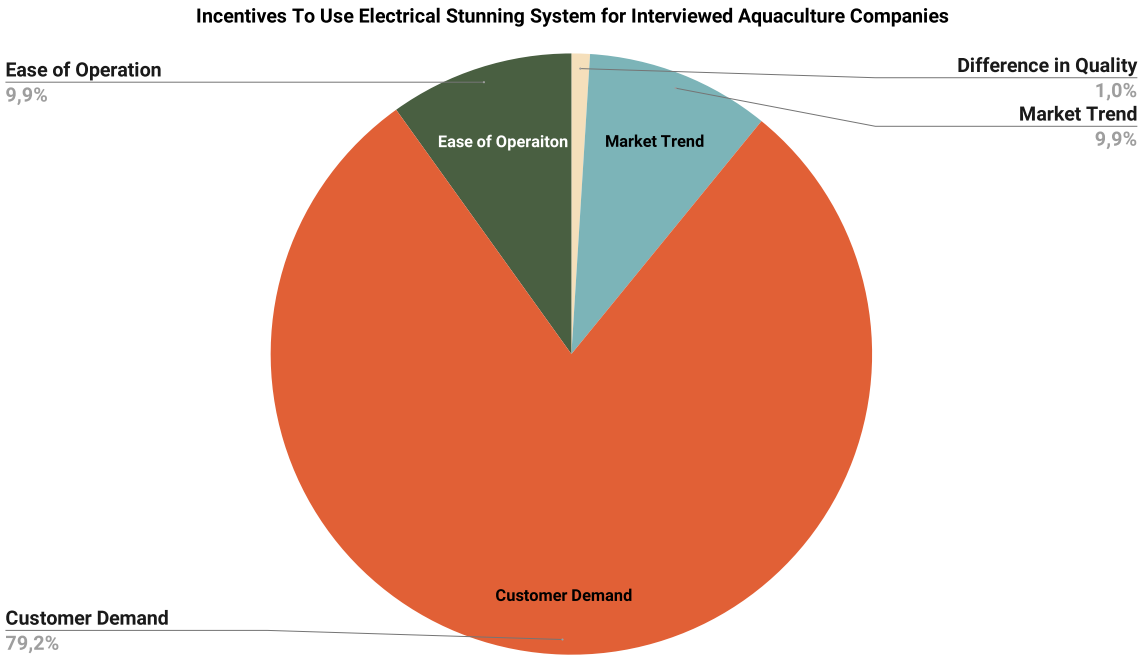

Figure 12: Factors encouraging the use of electrical stunning systems for the interviewed producers.

One producer noted the following advantages of electrical stunning: *"We observed that harvesting fish in a healthy way was a factor that increased product quality. Preventing fish from struggling and losing their scales helps maintain product quality. This was an important finding because fish losing their scales during harvest leads to deterioration in product quality. We analysed the amount of scales in the harvests and observed a*

significant advantage in harvests using the electrical stunning system. The live chilling method results in a 1% to 1.5% increase in scale loss due to the inability to sell damaged fish, translating to a significant 1% loss in overall weight during the harvest. In contrast, the notable advantage of electrical stunning lies in its remarkable ability to minimise scale loss. This inherent capability allows the system to rapidly recoup its initial cost. Thanks to this efficiency, the electrical stunning system demonstrates a swift return on investment, rendering it economically appealing."

Fish harvested using the live chilling method may bleed due to struggling in the tanks, and the product quality of fish kept in bloody water may be negatively affected. For example, according to a producer, if fish are kept in bloody water for at least two hours, negative effects on product quality may come about.

Comments of producers regarding the market reached by fish harvested by electrical stunning are as follows: "*The use of electrical stunning offers many advantages in addition to the price advantage. This method increased customer satisfaction in particular. After starting to use electrical stunning, a significant decrease in the number of complaints from customers was observed. Offering a quality product at the same price increases customer loyalty and is a reason for preference. The contribution of electrical stunning to fish quality offered the opportunity to provide customers with better products. This has increased customer satisfaction and provided a competitive advantage in the industry.*"

According to another producer, personnel accustomed to using the live chilling method have difficulty adapting to the electrical stunning system at first, but after a while, they begin to prefer this system, which is a more practical and faster harvest method.

The use of electrical stunning can offer many advantages over the live chilling method. Especially in species such as gilthead seabream and European seabass, minimising the rigor mortis of fish and gill rupture, skin changes, and bleeding can contribute to increasing product quality and shelf life. While this situation creates the opportunity to offer higher quality and longer-lasting products to customers, it can also positively affect consumer preferences. This is because when the live chilling method is used, bleeding occurs due to gill rupture, so even if the fish is fresh, after the tenth day, before it expires, it emits a smell that the customer complains about. Also, the colour of the gill changes due to blood and may turn brown, so there may be a complaint that the fish is stale. Therefore, aquaculture

farmers using electrical stunning can provide economic benefits with this method.

According to a producer's own research, electrical stunning extends the shelf life by one and a half days.

7.Our recommendations

Our recommendations, based on the findings from the surveys, are to improve fish welfare in the sector, influence market demand, encourage collaboration across the industry, increase sustainability, and improve the regulatory framework. It is also necessary to contribute to the development of fish welfare standards at the global level. These recommendations indicate that all stakeholders in the industry can work together to improve fish welfare and adopt more humane harvesting methods.

7.1 Industry Awareness and Training:

Industry Awareness and Training Programs: Up-to-date training programs for professionals in the aquaculture industry should be held on a regular basis. These programs will ensure that employees have up-to-date knowledge and skills on fish welfare. Additionally, these training programs will encourage more effective fish welfare practices in businesses. Besides, faculties of Fisheries Engineering at universities can incorporate fish welfare into their curriculum and thus raise awareness about fish welfare among students who will be fisheries engineers.

Development and Dissemination of Best Practices: Universities, producer associations, and public institutions should identify best practices for fish welfare and disseminate them throughout the industry. This will encourage farming businesses to implement better standards and guidelines.

7.2 Market Demand

Raising Awareness: Collaboration should be made with retailers and consumers regarding the effects of harvesting methods that do not use electrical stunning systems on fish welfare. Retailers can contribute to education and awareness efforts to better inform their customers. Consumers need to have more information on this issue to make informed choices.

Retailer Commitments: Many producers declared that the necessary equipment and facilities for the use of electrical stunning were available and that they could transform their harvesting if there was demand from their customers. Retail companies' use of electrical stunning during harvest throughout their supply chains will highlight them as a leading brand in fish welfare and prevent the suffering of millions of animals.

Producer Commitments: A company's commitment to adopt fish welfare standards in all its harvesting ensures confidence in consumers. Turkish producers' commitment to using electrical stunning in all of their harvesting will increase the brand value of the Turkish aquaculture sector. Doing so will also encourage retailers who want to invest in this area. Producers can also prevent the unbearable pain suffered by millions of animals every year by making this simple but very effective decision.

In this way, retailers and consumers can encourage better fish welfare practices and support this important change in the industry.

7.3 Industry Collaboration

Addressing Installation Challenges: The challenges associated with installing an electrical stunning system require collaboration between aquaculture businesses, equipment manufacturers, and researchers. For a successful installation of electrical stunning, the following issues must be addressed and resolved:

- **Supply of Spare Parts:** Supply of spare parts for electrical stunning machines can sometimes take a long time, which can disrupt the business of fish farmers. To eliminate this problem, farming businesses and equipment manufacturers can develop strategies to shorten the spare parts supply period.
- **Machine Malfunctions:** Malfunctions that may occur in electrical stunning machines may lead to extra maintenance costs for producers. Farming businesses and equipment manufacturers can work to increase the durability of machines, use machines more efficiently, and reduce maintenance requirements.
- **Fish Pump:** Many producers have provided feedback specifically regarding the problems related to fish pumps. It is difficult to use fish pumps with European seabass, especially since the European seabass must not be squeezed. Therefore, fish pumps need to be developed and fish pump manufacturers and electrical stunning manufacturers need to try to find a solution to this issue.

- **Problems Due to Boat Sizes:** Many producers have reported that boats are too small for the installation of electrical stunning systems. This poses a challenge in their installation. Farming businesses and equipment manufacturers can collaborate to develop installation solutions for smaller boats.
- **Blind Spots:** Some producers have reported blind spots occurring as a result of fish tanks that are inaccessible due to where the machine is installed. This means that in some cases the harvest cannot be done entirely by electrical stunning. Aquaculture businesses and equipment manufacturers can work to address this issue and develop more efficient harvesting methods.
- **Harvest speed:** Slowness in harvest time should be addressed as much as possible, prioritising fish welfare. Eliminating this slowness should be a goal when using electrical stunning.
- **Difficulties of Use in Stormy Conditions:** The use of electrical stunning may become difficult in stormy weather conditions. To deal with such problems, electrical stunning manufacturers and users must develop appropriate solutions, such as preventing air entrapment in hoses.
- **Education and Communication:** It has been observed that some problems with the use of electrical stunning may arise from lack of practice. Therefore, staying in touch with electrical stunning manufacturers and providing employees with training on the efficient use of the machine can help users use these systems more effectively.

Overcoming these problems requires active cooperation among producers, equipment manufacturers, researchers, and associations working on fish welfare. Resolving these issues for more widespread adoption and effective use of electrical stunning will provide significant progress in the industry.

Knowledge and Experience Sharing:

Sharing of knowledge and experience within the industry should be encouraged. Fish farming businesses should share their experiences and best practices with each other for more effective use of electrical stunning. This can increase efficiency in the industry and help find solutions to problems faster.

8. Conclusion

In conclusion, this research underlines the importance of preferring the use of electrical stunning systems over traditional methods that cause pain to

fish. Based on the results of our research, the majority of aquaculture farmers in Türkiye have electrical stunning systems but do not use these systems consistently at all stages of harvest. To achieve this goal, industry stakeholders must cooperate, legal regulations must be reviewed, and market demands must be shaped in this direction.

The electrical stunning system not only increases fish welfare but also has the potential to increase customer satisfaction. Therefore, the commitment of all aquaculture companies to use this more humane approach will enable them to gain a leading position in the industry. It should be noted that the electrical stunning system benefits not only fish welfare but also producers. In this context, encouraging all producers to use electrical stunning systems in every harvest is of great importance in supporting this positive change in the sector.

This research report aims to contribute to improving fish welfare standards in Türkiye's aquaculture sector. **Considering Türkiye's rapid growth in this sector and its influence in international markets, these changes could have a major impact not only nationally but also internationally.** The use of electrical stunning systems by aquaculture farmers in all their harvests is a critical step for the progress and future transformation of the sector. For this purpose, we aim to address the problems faced by electrical stunning system manufacturers and aquaculture businesses, offer solutions to the problems, and emphasise the advantages of the electrical stunning system, so that more humane harvesting methods become widespread in Türkiye.

Some companies interviewed already use electrical stunning on 100% of their harvests, proving that this is possible. Again, in light of the information obtained from the field, we can say that the advantages of the electrical stunning system outweigh its disadvantages.

With this report, we aim to offer solutions to the problems facing the use of electrical stunning systems and to pave the way for harvesting with more humane methods in Türkiye by underlining the advantages of the electrical stunning system. We invite everyone to cooperate to achieve this goal.

The data presented in this report are based on current research and the remarks of interviewed aquaculture farmers. The effects of the electrical stunning system on fish welfare, particularly on gilthead seabream and European seabass, require further research. Therefore, the data presented in the report may change over time and should be re-evaluated based on future research.

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