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Profitability of animal welfare

– A German pig fattening business participating in the German animal welfare initiative “Initiative Tierwohl”

Jana Zibolka

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Profitability of animal welfare – A German pig fattening business participating in the German animal welfare initiative "Initiative Tierwohl"

Lönsamhet för djurs välbefinnande – hur deltagande i det tyska djurskyddsinitiativet "Initiative Tierwohl" inverkar på ett lantbruksföretag med grisuppfödning

Jana Zibolka

Supervisor:	Anders Herlin, SLU, Department of Biosystems and Technology
Co-supervisors:	Prof. Dr. Oliver Mußhoff, Georg-August-University Göttingen, Department for Agricultural Economics and Rural Development
	Dr. Michael Danne, Georg-August-University Göttingen, Department for Agricultural Economics and Rural Development
Examiner:	Jenny Yngvesson, SLU, Department of Biosystems and Technology and Department of Animal Environment and Health

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SLU, Swedish University of Agricultural Sciences
Faculty of Landscape Architecture, Horticulture and Crop Production Science
Department of Biosystems and Technology

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Abstract

Increasing numbers of people are concerned about the conditions of farm animal husbandry systems and of the whole meat industry as well as of the welfare of farm animals in Germany. The willingness to pay for animal welfare-friendly products is increasing, while until now there is only one market-based farm animal welfare (FAW) label in Germany, the “Initiative Tierwohl” (ITW). This initiative is the first cross-sectoral alliance of the agricultural industry, the meat industry and the food retailing. The purpose of this on farm-study was to gain insights into the concept of animal welfare and to analyze the economic effects on a farm with fattening pigs participating in the ITW. Further, the farmer´s evaluation about current challenges in the fattening pig sector as well as his motivation for implementing higher FAW standards were examined. Five methods were applied: a literature review, a qualitative interview, a business segment accounting, an extra-cost accounting and a risk analysis. The results of the literature review showed the need for a uniform definition of FAW, unified measuring tools for FAW and the necessity using participatory approaches developing generalities. In this study four different scenarios were examined: the ITW program phase from 2018 to 2020, the program phase of the ITW from 2021 to 2023, the planned German state label and a control scenario. The analysis regarding the extra costs per pig of the FAW programs demonstrated that the opportunity costs keeping lower amounts of pigs, caused by the space requirements of 10 % and 20 % more space, form the highest cost position. The payed renumerations of 5,10 €/pig and 5,28 €/pig in the ITW-scenarios are enough to cover all incidental extra costs. The planned German label has to face high singular investment costs and a presumed renumeration of 6,00 €/pig would not be enough to cover the extra costs. Participating in the ITW leads to reduced fluctuations of the contribution margin of about 11 %, also called hedging effectiveness. Analyzing economic effects of FAW programs on farms represents an instructive approach to reflect the design of such a program. Further research is needed to analyze which factors determine the profitability of FAW programs the most. Risk-reducing effects of higher FAW standards have to be examined more in detail, for instance including potential positive synergies between FAW and animal health. Considering farmers´ individual risk attitudes will give more concrete recommendations for action in the end.

Abstrakt

Ett ökande antal personer visar oro över djuruppfödning och djurhållning. Detta gäller även skötseln och skyddet för lantbruksdjur i Tyskland. Konsumenter som är villiga att betala för produkter som har en inriktning på bra djurvälfärd ökar. Det finns för närvarande en marknadsbaserad djurvälfärdsmärkning, eller en så kallad 'market-based farm animal welfare label' (FAW) i Tyskland, nämligen "Initiative Tierwohl" (ITW). Detta initiativ är den första övergripande sammanslutningen inom jordbruks-, kött- och livsmedelsindustrin. Syftet med denna studie var att få en inblick i ämnet djurskydd och djurvälfärd för att undersöka de ekonomiska effekterna hos en gård med slaktsvin som deltar i ITW-initiativet. Dessutom undersöktes jordbrukarens egna bedömningar av de aktuella utmaningarna inom sektorn för slaktsvin och hans motivation att genomföra en högre nivå av FAW-standarder. Fem metoder användes: litteraturstudie, en kvalitativ intervju, en analys av verksamhetsgrenar, en merkostnadsberäkning och en riskanalys. Resultaten av den genomgångna litteraturen visade på behovet av en enhetlig definition av FAW, enhetliga mått för FAW och behovet av att använda metoder som är inkluderade under en sådan process. Fyra olika scenarier undersöktes i denna studie: ITW-programmet under 2018 och 2020, ITW-programmet från 2021 till 2023, den planerade nationella märkningen i Tyskland och ett scenario som användes som kontroll. Analysen av merkostnaderna per gris under FAW-programmet visade att alternativ kostnaderna utgör den högsta kostnadsposten för ett mindre antal grisar när utrymmeskraven ökar med 10% resp. 20%. Det räcker med en ersättning på 5,10 € per gris och 5,28 € per gris i ITW-scenarier för att täcka alla rörliga kostnader. Det planerade tyska djurvälfärdsmärkningen kommer att innebära höga investeringskostnader och en beräknad betalning på 6,00 € per gris räcker inte för att täcka merkostnaderna. Deltagande i ITW leder till att fluktuationerna i täckningsbidraget minskar med cirka 11%. Ytterligare forskning behövs för att analysera vilka faktorer som bäst avgör lönsamheten för ett FAW-program. Att högre FAW-standard skulle minska riskerna behöver undersökas ytterligare, till exempel genom att integrera potentiella positiva synergier mellan FAW och djurhälsa. Att ta hänsyn till jordbrukarnas individuella attityder till egen risk kan ge mer konkreta rekommendationer för framtida åtgärder.

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Foreword

After starting the Agroecology Master´s program, I was a bit skeptical how Agroecology as a holistic approach, encompassing social, economic and environmental dimensions of the food system, will be processed during the offered courses. But having the opportunity to connect with so many different people from the farm sector through excursions and farm visits and working with several international students with experiences in different areas of agriculture, like nutrition or advisory service, encouraged me to look at the bigger picture. For instance, learning about participatory approaches as useful tools to bringing together various, even controversial, positions, was a new research area which I did not had experiences with before. During the Master´s program I skilled my ability always considering the impact assessment of certain decisions because especially in agriculture a choice accompanies always with effects on the farm and its surrounding environment. Nevertheless, I took two Erasmus-semester abroad to learn more in detail about risk in agriculture, corporate social responsibility in the agrarian sector and socioeconomics in rural development and food security. I am grateful for the opportunity for going abroad and very satisfied of how I structured my Master. The combination of different teaching practices and the wide range of subjects definitely extended my range of knowledge and improved my analytical thinking.

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Abbreviations

&	And
m^3	Cubic meter
m^2	Square meter
€	Euro
%	Percent
a	Year
AG	Aktiengesellschaft
AMI	Agrarmarkt Informations-Gesellschaft
ASF	African swine fever
BfR	Bundesinstitut für Risikoforschung
BLE	Bundesanstalt für Landwirtschaft und Ernährung
BMEL	Bundesministerium für Ernährung und Landwirtschaft
BSE	Mad cow disease
BVDF	Bundesverband der Deutschen Fleischwarenindustrie e.V.
CAP	Common Agricultural Policy
CM	Contribution margin
d	Day
DBV	Deutscher Bauernverband e.V.
Dcfp	Direct-cost free performance
DLG	Deutsche Landwirtschafts-Gesellschaft e.V.
DLV	Deutscher Landwirtschaftsverlag e.V.
DRV	Deutscher Raiffeisenverband e.V.
E.g.	Exempli gratia
et al.	Et alia
etc.	Et cetera
EU	European Union
e. V.	Eingetragener Verein
FAW	Farm animal welfare
FAWC	Farm Animal Welfare Council
FCEC	Food Chain Evaluation Consortium
g	Gram
GCAW	Global Coalition for Animal Welfare

GmbH	Gesellschaft mit beschränkter Haftung
h	Hour
ITW	Initiative Tierwohl
ITW1	Initiative Tierwohl from 2018-2020
ITW2	Initiative Tierwohl from 2021-2023
kg	Kilogram
KTBL	Kuratorium für Technik und Bauwesen in der Landwirtschaft
LWK	Landwirtschaftskammer
OECD	Organization for Economic Co-operation and Development
OIE	World Organization for Animal Health
QS	Qualität und Sicherheit GmbH
RKI	Robert Koch Institut
SARS	Severe acute respiratory syndrome
SSB	Schweinespezialberatung e.V.
TGI	Tiergesundheitsindex
UBA	Umwelt Bundesamt
UK	United Kingdom
VAT	Value added tax
VDF	Verband der Fleischwirtschaft e.V.
VZBV	Verbraucherzentrale Bundesverband e.V.
WBA	German Scientific Advisory Board on Agricultural Policy
WHO	World Health Organization
ZDG	Zentralverband der Deutschen Geflügelwirtschaft e.V.

1 Introduction

1.1 Animal welfare in Germany

In recent years, the German livestock farming sector was often shaped by public debates about the status quo of farm animal welfare[1] (FAW). Lately, this was for instance the discussion about sows in gestation stalls, or the castration of piglets without anesthesia (Tonsor et al. 2009; WBA 2015). The present scandal of several onsets of the severe acute respiratory syndrome (SARS) coronavirus in German slaughterhouses intensified the discussion about working conditions in the livestock farming business and in general about FAW (WBA 2015). In Germany, as well in other countries around the world, the agricultural livestock farming lost social acceptance and became a contentious issue (see for example European Commission 2015; Ohl & van der Staay 2012; Roosen et al. 2018; Uehleke & Hüttel 2019; WBA 2015). The German Scientific Advisory Board on Agricultural Policy (WBA) states that the current husbandry conditions for a large share of farm animals in Germany are not sustainable against the background of societal change and new scientific evaluation approaches (WBA 2015).

A review on studies shows a raising demand for products coming from agricultural farming systems with higher FAW standards, and in general products with environmental benefit (Betz 2019; European Commission 2015; Heise 2016; Yang 2017). The phenomenon of the Consumer-Citizen-Gap plays a major role within the debate about the success of FAW label because the preferences of consumers as citizens often differs from their consumer conduct and willingness to pay on the market (Busch & Spiller 2020). The societal support is crucial for the durability of the German agriculture, also because the subsidy payments for supporting investments in the agricultural sector are coming from public authorities having a legitimate interest in its distribution (Sundrum 2018). In this context, the reputation can be seen as a significant social capital resource which supplies access to further resources like

[1] In the following, the term „animal welfare" is always referring to the welfare of farm animals in the context of agriculture, unless otherwise described.

information, which can lead to competitive advantage and the license to operate[2] (Heise 2016; Lin 2020).

On farmers level, conflicts in general with prospective regulatory laws and compliances as well as with the implementation of regulations in regard to FAW and environment protection are part of this discussion too. In this context examples are the uncertain conformity of the compliance of the German Federal Immission Control Act with free-range husbandry systems for fattening pigs, the discussion about the size of livestock and the surplus of manure or the use of pharmaceuticals. From farmers´ perspective, FAW will be one decisive issue in the long-term, whereby an increased willingness to implement FAW can be observed (Heise 2016; Pirsich 2017).

Within the scope of the discussion about the feasibility of more FAW in livestock farming, a common understanding of the meaning of animal welfare has to be clarified, though a common definition of animal welfare does not exist yet, neither in science nor in policy (Arndt 2019; Heise 2016; Sundrum 2018). Animal welfare is a very complex concept that is why various stakeholders have different definitions of animal welfare, which impedes the development of an explicit measurement and assessment of animal welfare (FAWC 2006).

Nonetheless, policy programs like the Strategy for the ´Protection and Welfare of Animals from 2011 – 2015´ by the European Union (EU) on international level, reflect the raising attention of the topic of FAW on political level. Further, international cooperations, such as the EU funded project Welfare Quality[3], governmental labels like the Danish animal welfare label “Bedre Dyrevelfaerd” or the prospective German state label “Staatliches Tierwohlkennzeichen”, labels from national associations, as the German voluntary label “Initiative Tierwohl” (“Animal welfare label”), in addition to that the unified label “Haltungsform” (“Forms of Livestock Farming”) classifying consisting German animal welfare

[2] The license to operate deals with the social acceptance of companies, technologies and products and is based on the intersubjective perception of society. Due to increasing criticism of companies today, ensuring the license to operate is essential for long-term legal capacity and cooperation capability (Wilburn & Wilburn 2011).

[3] The Welfare Quality project was an international project from 2004 to 2010, financed by the EU. The participants developed animal-specific guidelines to determine animal welfare on farms. The assessment of the animals is based on the four principles: good feeding, good housing, good health and appropriate behavior (Welfare Quality 2009).

labels into four categories from lower standards of FAW to higher levels of FAW, or private FAW standards like the "Privathof Geflügel Label"[4], are part of this development (European Commission 2012; Hedman et al. 2018). In recent years, the trend in establishing labels for agricultural products became considerably common in most of the large consumer countries, even though the market for FAW labeled meat is developing slowly (Heise 2016; Vanhonacker et al. 2014; WBA 2015).
In addition to the political, societal and scientific development, a great structural trend in the German livestock farming sector was observed during the last fifteen years. Focusing on the pig sector, a decline in the amounts of livestock farmers was registered while simultaneously the whole pig stock remained constant (Statistisches Bundesamt 2020).

The arising conflict of objectives between maintaining competitiveness within an international market, structural transformation, environment and animal protection, societal demands and various attitudes of different stakeholders, moving forward to a more sustainable livestock husbandry system, ensuring sufficient working conditions and the disagreement on a common definition on FAW represent the complexity of the problem of implementing higher FAW standards in the German livestock farming sector. These mentioned uncertainties in combination with environmental risks like man-made climate change, lead to the question of appropriate on-farm risk management as an integral part of management decision making (Hardaker et al. 2016). Hedging the appearing consequences due to various sources of risks gets more and more important and common for agricultural businesses (Iglesias et al. 2012; Offermann et al. 2017; Schaper et al. 2012).

Against this background, the German animal welfare labeling initiative "Initiative Tierwohl" (ITW), resolved in 2015 and implemented on the market in 2018, positions itself in the complex discussion about FAW and tries to support more FAW and innovation in the livestock farming business on a voluntary base, that

[4] The concept of the "Privathof Geflügel" label of Wiesenhof, market leader for poultry in Germany, contains the use of slower growing breeds, a lower animal density, manipulable materials, such as picking stones, and winter gardens (Wiesenhof Geflügelkontor GmbH 2020).

labels only better qualities. An alliance of farmers, farmer organizations, the meat industry and food retailers established this initiative and presently, 6.427 farms with fattening pigs, piglet rearing, sows, broilers and turkey are part of it (ITW 2020a). Currently, the market share of fattening pigs within the ITW accounts for 31 %, for broiler and turkeys the market share is around 70 % (DBV 2020; ITW 2020c).

Higher animal welfare standards have to be economically viable for farmers. In this context, Sundrum (2018) emphasizes the importance of the reward of taking efforts to enable more animal welfare on a plant level. Resulting from this problem, there is a lack of needful resources for implementing higher FAW standards. Under current market conditions, livestock farmers depend on external grants that are linked to a verification of those higher standards to cover high production and investment costs. The WBA expects additional total costs of 3 – 5 billion Euro a year for the implementation of higher animal welfare standards which means an increase in consumer prices of around 3 % to 6 % (WBA 2015). In comparison, the Borchert-Commission (2020) calculates with 1,2 billion Euro to 3,6 billion Euro for all kind of farm animals, depending on the level of implementation[5]. The fond of the ITW, provided by the food retailing, allocated 646 million Euro for the program phase from 2015 to 2020 (ITW 2020b).

Farmers are considered as the significant stakeholder group for the long-term success of FAW programs because the implementation of more FAW, additionally to the legal minimum standard, is currently still their free choice, independently from downstream stages of production. The analysis of the overall effects of the ITW on farm level is crucial for convincing farmers to participate in the initiative and to develop the ITW further to a sustainable market-based instrument for higher FAW standards. The joint reflection of the profitability of the ITW and the effects on the risk profile of the fattening pig business segment will give important information about the on-farm impact participating in an FAW program, in this case the ITW.

[5] The detailed elaboration of proposals from the WBA and the Borchert-Commission are illustrated in Table A 1.

1.2 Objectives and Procedure

The master thesis will be structured into one qualitative interview and two main economic sections that build upon one another to answer the three research questions, targeting at the evaluation of the ITW on plant level:

(1) *What is the farmers motivation to participate in the ITW and in this context, how does he evaluate current risks and their extent and probability of loss?*

(2) *How large are the effects of the fix ITW-price for implemented higher animal welfare standards on the profit of the pig fattening farming business?*

(3) *In what way can the ITW be seen as a risk management tool for the pig fattening farming business?*

The interview with the farmer aims at giving an insight in the farmers motivation participating in the ITW, his evaluation of current challenges in the fattening pig business and previous implemented risk management strategies.
The first economic section deals with the initiatives impact on the farms profit. This part contains an extra-cost accounting of three FAW-scenarios: the ITW1 program phase from 2018 to 2020, current ITW2 phase from 2021 to 2023 and the planned German state label. Additionally, effects of participating in the ITW1 on the business segment accounting are evaluated in regard to the question if the compensation rate of the ITW1 is enough for accomplish financial compensation for incidental extra costs. Further, the thesis aims at analyzing the extensive impacts of the ITW as a risk management tool by means of historic and stochastic simulation. Besides, a price scenario analysis of the pig, piglet and feed prices should give indications at which price combination the ITW1 might be unprofitable.

The object of investigation will be a conventional German farm with the production branch of fattening pigs participating in the ITW1 since 2018. The analysis by means of a practical example should increase the validity of the impacts and the valuation of the ITW, and based on the results as well as on the

discussion result in an attempt to make a policy recommendation in form of a factsheet which aims to give references about the feasibility and future viability of the practical implementation of FAW programs.
The ITW is taken as the first German animal welfare label designed as a cross-sectoral alliance of the agricultural industry, the meat industry and the food retailing initiating a change in the livestock farming sector via financial support of the food retailing.

There exist already some studies dealing with extra costs of animal welfare measures. The “Deutsche Landwirtschafts-Gesellschaft e.V.” (DLG) for instance examined the profitability of investments in FAW for a conventional fattening pig farm considering the recommendations for higher FAW standards of the WBA (2015) at four different pig performance parameters (DLG 2016). Within the Thuringian Animal Welfare Strategy, cost calculations were made for higher FAW standards in the fattening pig sector including more space, offering additional manipulable material and alternatives for piglet castration without anesthesia (Müller & Gräfe 2019). Other studies dealt with the economics of general FAW in regard to alternatives for chick culling (Reithmayer 2020) or evaluated the costs under different housing systems like Seibert and Norwood (2011) accounted the production costs under different hog production systems. Bornett et al. (2003) examined the profitability of rearing pigs in a range of housing systems with various standards for pig welfare.
The profitability of the ITW was evaluated to some extent by the Chamber of Agriculture in North Rhine-Westphalia (Leuer 2017) and by Schukat & Heise (2019a; 2019b), who analyzed by means of a full cost accounting the profitability of all potential criteria of the ITW criteria catalogue on data basis of the “Kuratorium für Technik und Bauwesen in der Landwirtschaft” (KTBL) for three fictional plants which differ in terms of their performance level.
Considering risk analysis and profitability calculations combined, Momeyer (2011) simulated the net value present with the stochastic simulation for three different investment decisions: pig fattening, broiler fattening and biogas. Wüstholz (2011) examined the risk of investment decisions for fattening pig businesses. Often, such studies are based on costing data of the KTBL.

So far, there are a few studies about the general assessment of the ITW from farmer´s point of view (Winkel et al. 2019), from the consumer´s perspective (Zühlsdorf et al. 2016) and from the point of view of various stakeholders (Heise et al. 2017). Further, there is existing a great pool of studies dealing with stakeholder analysis regarding animal welfare in livestock farming in general (Heise 2016; Krieger et al. 2020; Vanhonacker & Verbeke 2014; Verbeke 2009; Wildraut et al. 2018). Heise (2016, p. 264) analyzed “whether farmers who already participated in animal welfare programs consider their economic success more satisfactory than do conventional farmers who do not participate in those programs” and identified several perceived advantages and disadvantages by the stakeholders of the livestock farming sector. Since little is known about the specific effects of the ITW on plant level, especially with effects on the risk profile, the present thesis will examine the profitability of the ITW with an example of a German fattening pig business.

Firstly, chapter 2 gives an overview about the theoretical framework in the field of animal welfare. The chapter 2.1 focuses on the general concept of animal welfare and the various existing definitions (2.1.1), followed by an analysis of the current stakeholders and supply of FAW (2.1.2 and 2.1.3). The subsection 2.1.4 presents the possibilities of funding more animal welfare production systems. In chapter 2.2 the risk in livestock production will be shortly introduced as well as the pig production industry in Germany will be constituted, with a focus on the development of fattening pig sector (2.2.1) and the previous achievements and problem areas in animal welfare (2.2.2 and 2.2.3). Subsequently, chapter 2.3 deals with the analyzed farm case. The methodology of the thesis is part of chapter 3. The results are presented in chapter 4, subdivided following the described methods of the previous chapter. In chapter 5 the applied methods are discussed regarding their feasibility, the limitations of the thesis are elaborated, and the validity of the results will be reflected in a broader context. Finally, in chapter 6 the conclusion forms the summary of the most important statements and results. Chapter 7 gives an overview about the used references, followed by the appendix in chapter 8. Additionally, a policy recommendation for the practical applicability in terms of the effects of the ITW will be developed in form of a factsheet for initiators of FAW programs.

2 Literature review

2.1 Animal welfare

2.1.1 The concept of animal welfare

In 1965, the so called “Brambell Committee”, commissioned by the United Kingdom government to investigate the welfare of intensively farmed animals, published the first widely accepted framework to capture the key aspects of animal welfare. Based on this report, five separate freedoms, which together provided a holistic picture of animal welfare, resulted:

1. Freedom from hunger and thirst
2. Freedom from discomfort
3. Freedom from pain, injury or disease
4. Freedom to express normal behavior
5. Freedom from fear and distress.

This concept laid the foundation to define animal welfare as a wider term that encompasses both the physical and the mental aspects of the animal (Brambell 1965). Also, the understanding of animal welfare in the EU is based on these five freedoms (European Commission 1976).

Fraser (2009) worked out three objectives which define a comprehensive view on animal welfare: ensuring good physical health and functioning of the animals, minimizing unpleasant affective states like pain and fear, and allowing animals to act in their natural way. Those three objectives interact with each other but can also stand against each other. Their application is limited due to the difficulty of analyzing animal welfare when animals adapt to current circumstances and the three stated objectives came from different philosophical views about what defines good animal welfare (Fraser 2009).

The World Organization for Animal Health (OIE) encompasses all the mentioned approaches and published a definition of animal welfare in 2008 on which 118 nations agreed on, including Germany. Currently, this definition builds the strongest reference for the term animal welfare and is defined as follows:

“*Animal welfare means the physical and mental state of an animal in relation to the conditions in which it lives and dies. An animal experiences good welfare if*

the animal is healthy, comfortable, well nourished, safe, is not suffering from unpleasant states such as pain, fear and distress, and is able to express behaviors that are important for its physical and mental state.
Good animal welfare requires disease prevention and appropriate veterinary care, shelter, management and nutrition, a stimulating and safe environment, humane handling and humane slaughter or killing. While animal welfare refers to the state of the animal, the treatment that an animal receives is covered by other terms such as animal care, animal husbandry, and humane treatment" (OIE 2019a).

The guiding principles of the OIE (2019a) refer to value-based assumptions that are made and extend the term by an ethical responsibility to ensure the animals welfare.
Keeling and Kjærnes (2009), who worked in the project of Welfare Quality (2009), narrowed down the term on four principles: good housing systems, good management, good animal health and appropriate animal behavior. The holistic relation of those four criteria is illustrated in Figure 1.

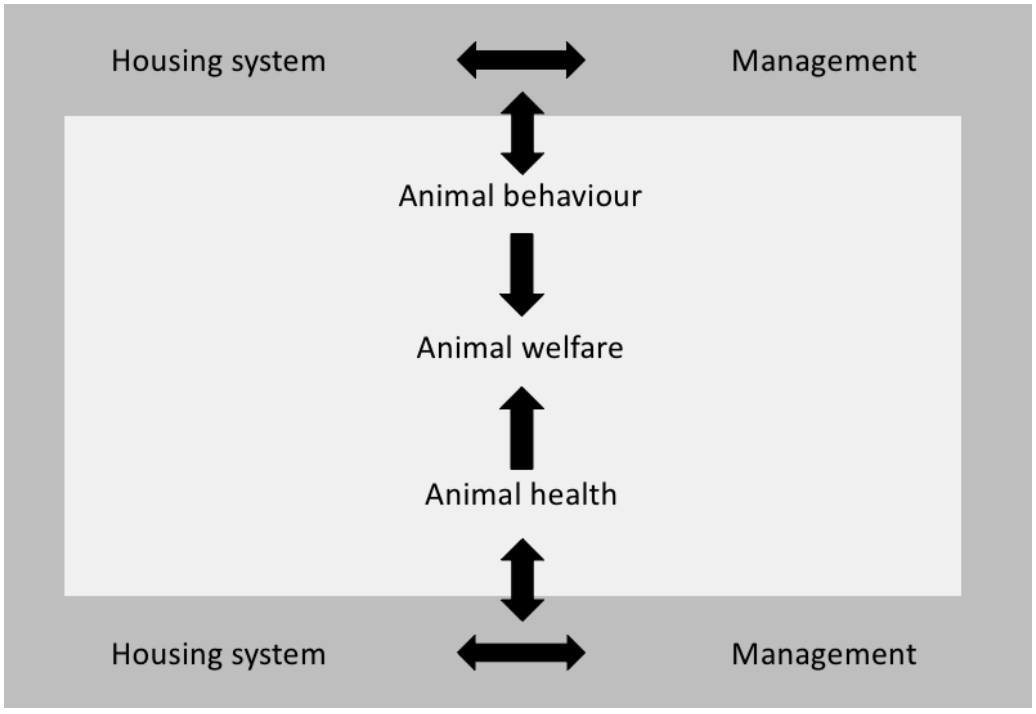

Figure 1: Principles for evaluating animal welfare (own illustration following Deimel et al. 2012; Keeling & Kjærnes 2009; Welfare Quality 2009)

The criteria housing systems and management are indirect factors which are controllable by the farmer. The criteria housing system refers for instance to the floor conditions and the building design of the stable, e.g. offering outdoor climate access, whereas the management relates to the way of working of the employees, e.g. frequent cleaning of drinking devices and managing the sick bays. They also influence the animal health and behavior which directly reflect the welfare of the animal. Animal health, encompassing criteria for a welfare assessment like a sufficient and appropriate diet, an accessible water supply, thermal comfort, high standards of hygiene and care, and animal behavior, including the possibility expressing social behaviors, like grooming, species-specific behaviors, e.g. foraging, and having resting areas and enough space moving around freely, are the two factors which, according to Keeling and Kjærnes (2009), directly affect the welfare on an animal the most.

Sandøe (2019) and Ohl and van der Staay (2012), in turn, focus, besides the scientific perspective, on the ethical component of animal welfare. The aim is to evaluate what is good or bad from the point of view of the affected animals while the welfare of individual animals has to be seen within the big picture. The definition of animal welfare cannot be limited in time, not only due to breeding progresses and new technology but also climate change and availability of natural resources influence the insight of FAW (Arndt 2019). Beyond that, the optimized ability to interact with and adapt to the surrounding environments of animals is a driving factor which does not allow a fix definition over time and refers to a dynamic welfare concept (Ohl & van der Staay 2012).

Some scientists declare the regulation of animal welfare as a public good with a clear role for government policies in establishing and imposing standards because animal welfare provides an economic value which cannot be handled through the market (Vecqueray & Hambling 2018; Vetter et al. 2014). The welfare-productivity model of McInerney (2004) is based on the assumption that animal welfare is not a monetary cost appearing in the accounts of farmers and therefore not in the cost calculation of the supply of livestock products on the market. Thus, animal welfare is not a part of the market-driven process and in this sense seen as an externality cost. McInerney´s conceptual model,

concludes an increasing marginal rate of transformation[6] between perceived animal welfare and livestock productivity (human benefit). The welfare-productivity conflict within livestock production gets obvious.

A similar concept was developed by Harvey & Hubbard (2013), implicating that commercial pressures will always lead to a point of minimum welfare if there would not be a higher legislative level of animal welfare. According to their model, the process of continual competition for market share within the supply chain, continuous research and development and extension services will lead to improvements in animal productivity and animal welfare. Further, the choice of more FAW on the market depends on the stakeholders´ willingness to pay and the public awareness of the topic of FAW which develops over time.

Cultural and social values, specifically society´s moral understanding, are the major factors influencing the term animal welfare as well as the political relevance of animal welfare science (Ohl & van der Staay 2012; Sandøe 2019). Therefore, the understanding of animal welfare differs between cultures, regions and time (Yeates 2010).

Moreover, the perception of society depends on the context like scandals, for instance the crisis about the mad cow disease (BSE) or the horsemeat scandal. The Dutch Animal Welfare Council developed an ethical framework on animal welfare to identify relevant ethical issues and potential moral dilemmas to provide a basis for discussions (Ohl & van der Staay 2012). The basis to consider animal welfare ethically consists of societal moral, which is based on feelings, principles and facts, and relevant and actual scientific knowledge, for example economic interests, environment, domestication or evolution. Those two components are in continuous interaction with moral questions like ´Do we have the moral duty to take care of animal welfare?´

The term animal welfare has to be differentiated by the term animal health and animal protection which are often used as synonyms, in the German language as well as in English (Sundrum 2018). Whereas animal protection refers to the legality when dealing with animals, animal health is often defined as the absence

[6] The marginal rate of transformation says how many units of factor A need to be less produced to produce one unit of factor B (Mußhoff & Hirschauer 2016).

of physical, mental and social well-being of animals, not only the solely absence of disease or infirmity (Nicks & Vandenheede 2014; WHO 2006). The concept of animal welfare extends the term of animal health by considering conditions of living, expression of natural behavior, appropriate management and human handling and in general the environment aspect (Fraser 2009; Keeling & Kjærnes 2009; OIE 2019a).

Despite the existence of a nearly common definition such as presented by the OIE, animal welfare programs and initiatives often come up with own definitions of the term (Sundrum 2018). Several studies which tried to develop a universal definition of animal welfare are criticized for a consumer-based perspective without taking into account the complexity of involved stakeholders (Fraser 2008; Heise 2016; Vanhonacker & Verbecke 2014).

Another important point is the measurement of animal welfare. The following Table 1 gives an overview of selected parameters, based on a literature review, how to assess animal welfare at farm level. The realization of FAW assessments into management practice and the way these practices are viewed by society are affected by societal understanding and attitudes (Ohl & van der Staay 2012). Two major challenges are the determination of thresholds, under which a specific parameter cannot be seen as animal friendly, and to define minimum requirements. A third challenge is the difficulty of measuring animal-based parameters like fear or abnormal behavior for instance. The measurement requires time, labor, a common definition of FAW and sometimes expensive resources. Recorded results may be hard to interpret which complicates the welfare assessment (Johnsen et al. 2001).

Table 1: Parameters of assessment of farm animal welfare (own table)

Title of method/ project	Parameters of assessment of FAW	Source
Welfare parameters	Environmental (length of stalls, feeding, drinking facilities, quality of litter) and animal-based parameters (level of stress hormones, aggression, fear, abnormal behavior)	Johnsen et al. (2001)
Welfare Quality assessment	Welfare principles: good feeding, good housing, good health, appropriate behavior	Welfare Quality (2009)
Austrian Animal Needs Index (TGI 35 L)	Index system for on-farm welfare assessment: movement capacity, social contact, floor condition, stable climate, stockmanship	Ofner et al. (2002)
Animal Needs Index of QS	Respiratory health, health of organs, limbs health, integrity of carcass	Qualität und Sicherheit GmbH[7] (QS 2019)
World Organization for Animal Health (OIE)	Behavior, morbidity rates, mortality and culling rates, changes in body weight and body condition, reproductive efficiency, physical appearance, handling response, lameness, complications from common procedures	OIE (2019b)

[7] The “Qualität und Sicherheit GmbH“ (QS) is a quality assurance system encompassing all production and trade levels of meat and meat products. The system was started by the agri-food sector in 2001 and has its own label “QS” (QS 2021).

2.1.2 Stakeholders involved in farm animal welfare

In addition to, and following from, the widespread development of decreasing social acceptance towards the current livestock farming system, the different stakeholders along the animal production chain increasingly perceive the importance of animal welfare (Bracke et al. 2005; Verbeke 2009). The stakeholders´ interest in FAW varies to a great extent, as well as the potential share to higher FAW standards (Vanhonacker et al. 2014). Figure 2 represents the network of stakeholders involved in the topic of FAW in form of a spider diagram.

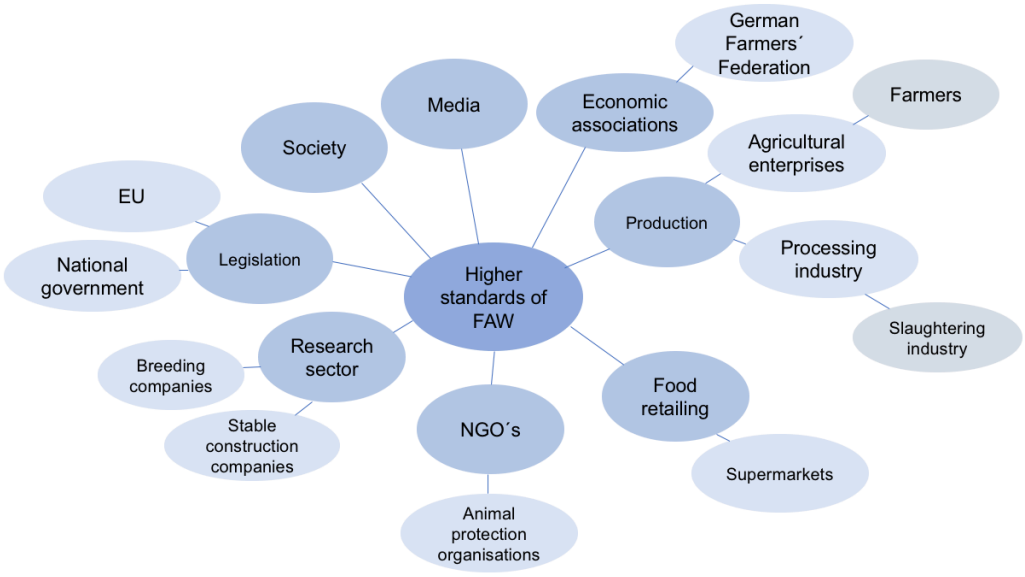

Figure 2: Stakeholders involved in implementing higher farm animal welfare standards (own figure based on Bracke et al. 2005; Verbeke 2009)

The **production side** consists of farmers and agricultural enterprises like "Wiesenhof" for instance which comes up with own private labels as the "Privathof-Geflügel" label, and the processing industry where the slaughtering industry plays a key role in participating in animal welfare initiatives, for example in monitoring slaughter results.

The **food retailing** is, together with the production sector, the main actor of the ITW, and initiator of the label "Haltungsform"[8]. The food retailing has to react on

[8] The label „Haltungsform" discloses the status quo of animal husbandry systems by categorizing these into four different categories: indoor stable systems, indoor stable systems plus, outdoor climate and premium (Haltungsform 2020).

the changing consumer behavior and at the same time consider the delivery conditions of farmers and suppliers. Furthermore, it is confronted with the competitiveness on the market with innovative, often risky, marketing measurements of companies which can lead to economic losses (Krampe et al. 2018).

Part of the public discussion about FAW are also the stakeholder groups of **politicians** and **actors of commercial trade**, which are positioned in the area of tension between the wishful thinking of consumers and the supply conditions of producers (Simons & Christoph-Schulz 2019). For a successful establishment of more animal welfare-based systems and FAW label like the ITW, the acceptance of the label by the various respective actors of the value chain is necessary, because animal welfare affects the whole value chain, whereas it is not enough to look at a single sector while introducing labeled meat (Franz et al. 2010; Heise 2016). Especially in high-income countries, such as the member states in the EU, where animal welfare standards in farm production are generally taken to be higher than in countries that export livestock products to the EU, the issue of FAW is receiving growing attention (Grethe 2017; Harvey et al. 2013; Roosen et al. 2016). In developing countries, the issue is becoming an essential part of the political agenda as well due to import requirements made by industrialized countries and domestic concerns about the prospective development of the agricultural sector (Grethe 2017). Another major driver for this development is, according to Fraser (2008), the formation of international corporations that focus on global supply chain requirements and consequently influence the animal production sector in developing countries, noticeably by the formation of Fairtrade or the Global Coalition for Animal Welfare (GCAW).

Economic associations like the “Deutscher Bauernverband e.V.“ (DBV) as the largest agricultural association in Germany, influence decisions on legislative level as well as societal discussions and act as a junction between farmers and political authorities.

The **research sector** contributes significantly to the development of more animal welfare-based systems like free-range housing systems, efficient manure management systems or dual-purpose breeds.

The **society** builds up the main demand side with consumers who decide on the success of an established product claiming higher FAW standards due to their

purchasing power. The development of decreasing social acceptance towards the current livestock farming system accompanies with a change in the consumption of animal products (Vanhonacker et al. 2014). There is a significant demand in poultry and pig meat from animal welfare-oriented production systems, because consumers tend to perceive a deterioration in quality here during the last years (Heise 2016). Around two-third of the German population consider existing husbandry practices as unacceptable (Roosen et al. 2016). A challenge remains the conflict of consumer attitude against animal welfare and the actual buying behavior which does not always reflect the stated preferences (Betz 2019; Simons 2019; Uehleke & Hüttel 2019). The consumer behavior varies between voluntary purchase situations, where the share of support is much lower, and mandatory purchase situations, where for example the public legislation regulates welfare-improved meat (Uehleke & Hüttel 2019). In this context, Uehleke and Hüttel (2019) point out the challenge of the success of voluntary FAW labels like the ITW label, due to the common free-riding incentive which has the potential to affect the demand negatively and consequently influences the market share of such products. The diverging opinions on the issue of FAW within the society are induced by heterogeneous conditions in German stables, oversupply of labels praising animal welfare, media influence and distortion of information (Christoph-Schulz et al. 2018). For example, the debate about an intact tail of fattening pigs and the problem of tail-biting has to be discussed objectively in regard of what is more animal welfare-oriented, the tail-docking or the risk of infections due to wounded tails (Heise 2016; Sundrum 2018). The effect is intensified by consumers´ impression of sealed stables, automated processes and as a consequence a perceived decreased contact between farmer and his animals (Simons & Christoph-Schulz 2019).

Media has the tendency to perceive negative information stronger than positive ones, which influence the perception of organizational wrongdoing and thus influence certain developments in a relevant way (Clemente & Gabbioneta 2017).

2.1.3 Supply of farm animal welfare

Food products with higher FAW standards are mostly made available through market-based concepts like market segmentation and product differentiation or competitive marketing (Harvey & Hubbard 2013; Vanhonacker & Verbecke 2014; Verbeke 2009). There are several initiators which can supply animal welfare products to consumers: governments, the private industry or industry cooperation and initiatives between different sectors. Hereinafter, different instruments and ways of supplying animal welfare are presented. Because the ITW markets their products via a label, a special focus will be on the description of this marketing channel.

Labels

In general, labels are a common opportunity to communicate animal welfare and to establish a market segment for products with higher FAW standards because they have the potential to attract new consumer segments while combining consumers who´s purchasing behavior is not yet adjusted with their level of interest in products with higher FAW standards (FCEC 2009; Verbeke 2005). Furthermore, labels signal certain credence attributes at the point of sale and are the primary base of a certification system, often taking into account third-party institutions like the government or animal welfare organizations (Heyder & Theuvsen 2009; Pirsich 2017). Labels are an approach to reduce information asymmetries (Gier et al. 2018) by “improving market transparency and allowing better-informed purchase decisions for consumers” (Mergenthaler & Schröter (2019: 145). Napolitano et al. (2010) characterized labeling as a tool for product diversification which has the potential to lead to higher consumer willingness-to-pay. Simultaneously, different motives between the consumer segments and the bounded rationality of consumers, correlated to information overload, are limiting factors for such a successful development of a label (Vanhonacker & Verbeke 2014). Mainly all in this section mentioned approaches can be implemented via labels. An overview of the various types of labels is shown in

There are two different approaches: for one thing, some labels claim only better qualities like the label for eggs mandatorily and the “Pro Weideland” label voluntarily simply for one specific resource, while on the other hand some show completely all standards of the livestock farming system, such as the voluntary

Danish label “Beter Leven”. Another classification of labels can be made regarding the initial driver of the label, for instance by producers or retailers (McInerney 2004). Harvey and Hubbard (2013) group labels into ones with 3rd party inspections and private labels without 3rd party inspections.
Table 2.

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Table 2: Types of animal welfare label (own illustration according to Spiller 2020)

	Animal welfare indicators	
	Resource-based indicators (farming system)	**Multidimensional indicators (including animal-based indicators)**
Mandatory	Mandatory resource-label  [9]	Mandatory comprehensive FAW-label
Voluntary	Simple positive-label  [10]	Comprehensive (positive) label

[9] Source: Bauernhof Brinkmann (2020)

[10] Source: Jongebloed (2017)

11

12

13

There is a clear trend towards labels with multiple stages, mainly voluntary ones. Mandatory FAW labeling initiatives are commonly rare, but the British Veterinary Association for instance requested for a mandatory FAW label (Pig World 2016). The only mandatory labeling scheme on animal welfare exists for table eggs in the whole EU (European Commission 2009).

For specific characteristics of food, especially for genetically modified products, several studies found a consumer preference for mandatory labeling (Loureiro & Hine 2004; Roe & Sheldon 2007). Tonsor & Wolf (2011) highlight the potential of mandatory labels in reducing consumers uncertainty regarding certain production practices and search costs of consumers comparing different labels. At the same time, there is the potential label information overload, the consumer-citizen-gap and the risk of the emigration of the livestock business in foreign countries with lower animal welfare standards (FCEC 2009; Gier et al. 2018; Tonsor & Wolf 2011). Another point of criticism is that, due to too many animal welfare labels, missing transparency and explicit labeling, labels have a decreasing credibility and a diminishing marginal utility (Verbraucherkommission Baden-Württemberg 2011; VZBV 2017).

Depending on the driver of the program, be it stakeholders, retailers, governments, farmers, processors or consumers, the content of voluntary labeling programs can vary greatly (Vanhonacker & Verbeke 2014). The Council of the EU (2019) and the European Commission (2020), which published the ´Farm to Fork Strategy´ as part of the EU Green Deal this year, consider a common European label for animal welfare, which might be realized in 2024, “to

[11] Source: Haltungsform (2020)

[12] Source: Beter Leven (2020)

[13] Source: ITW (2020d)

better transmit value through the food chain" (European Commission 2020, p. 10). Currently, the German government is planning a voluntary state label, initially for fattening pigs (BMEL 2020a). Labels claiming animal welfare are part of a broader label development towards sustainability in different sectors, mention can be made of the Fairtrade label, the Climate reduction label, the Carbon label and the Organic labels (Spiller 2020).

Private regulatory standards & industry arrangements

Private organizations and companies, such as the industry or farmers´ organizations, can develop additional FAW standards above the general legislation. Private efforts are for example taken by the food companies Vion and Westfleisch creating in each case an own food label claiming more animal-friendly production. Another example, Tönnies, an internationally operating German company in the meat industry, made efforts to reach an industry solution with selective internal efforts. The advantage is the plus of FAW which can increase consumer knowledge about animal welfare, if it is a well-designed private standard, and simultaneously leads to an increase in demand. Another opportunity is the flexibility as such standards can easily be changed and adapted to new circumstances while legislation developments seized longer bureaucratic processes (Hedman et al. 2018). But it is often difficult to keep an overview of the regulation and control area and the prospective outcome and development is difficult to predict. The lack of transparency of private standards and the overload of various private labels can be challenging for consumers as well (Hedman et al. 2018). The ITW for instance, is an example for a voluntary cross-industry network and represents a specialist function with accountability. The ITW worked without product segregation and labeled products at the point-of-sale until 2018 and started afterwards with a label. Mergenthaler & Schröter (2019: 145) described the initiative until introducing labeled products as "a quasi private tax-and-subsidy-system in the market". Arrangements along the value chain have legitimacy and power to start innovations with long-term prospects of success. Then again, there is criticism against the credibility of such an initiative and the ´real improvement´ of FAW standards for the animals (FAWC 2008; Heise 2016).

Public regulations

The approach of supplying animal welfare via legal minimum standards is forceful and transparent. On the other hand, national and international regulations can have counter-intuitive effects when there is a lack of specifying the alternative options and only an incentive to meet, not to exceed the standards. As an example, cage-rearing for laying hens is forbidden since 2012 in the EU, whereas small group housing systems with enriched cages for laying hens is still allowed but will be now prohibited in Germany in 2025 (BMEL 2015; FAWC 2008; Lusk 2011). Further, government interventions trying to provide a certain high level of FAW often have the risk of causing welfare losses for consumers who are not interested in FAW (Bennett 1997). Grethe (2017) assumes that FAW legislation might induce innovations and technological progress which can lead to decreased compliance costs. Taxes and subsidies are as well governance instruments but will be discussed more concretely in section 2.1.4.

Incentive payments for farmers through the Common Agricultural Policy (CAP)

Higher production costs due to animal welfare measures, long amortization periods and the specificity of investments are often misgivings of farmers when discussing the implementation of higher FAW standards (Grethe 2017; Wildraut & Mergenthaler 2018). On the other hand, implementing animal welfare criteria can lead to lowered production costs, e.g. savings in piglet and feed costs due to space requirements with lower amounts of kept animals, savings in veterinary costs, also because of potential improvements in biological performances, like increases in weight gains and lowered risks for injuries and death caused by environmental enriched stables systems and avoiding tail docking (Morgan et al. 2019). Incentive payments are part of the Second Pillar of the CAP and are characterized by an economic pressure and cross-compliance for farmers to behave acceptably, whereby those payments are one possibility for funding more FAW. Otherwise, incentive payments can be inflexible in the realization while predicting outcomes and results might be difficult (FAWC 2008). An example is the Commission´s animal welfare strategy from 2012 – 2015 which included measures to “optimize the synergies with rural development support for animal welfare” (European Court of Auditors 2018, p. 41).

2.1.3.1 German animal welfare initiative „Initiative Tierwohl" (ITW)

The ITW is a voluntary cooperation between the following share- and stakeholders, presented in Figure 3.

Figure 3: Participating shareholders and stakeholders of the ITW (own figure according to ITW 2020e)

The association aims to achieve an improvement of the conventional livestock sector in Germany, a broad implementation of the offered criteria (see Table A 2 and Table A 3) and a cross-sectoral effect while animal welfare is seen as a macrosocial task (ITW 2020e). Currently, 6.427 farmers are participating, in total 4.416 fattening pig farmers and 2.011 farmers with poultry. Overall, 553 million pigs and poultries are benefiting from the ITW. The intern structure of the ITW is divided into different project groups, which formulate the requirements and criteria of the FAW standards, the advisory committee, which develops recommendations for the future development of the ITW on basis of current research results, the finance committee, which is responsible for the liquidity planning, and the sanction committee, which acts as an independent neutral board to control the compliance of the contractual obligations of the participants of the ITW (ITW 2020e). The ITW can be categorized in stage two of the label "Haltungsform" (see Table 2).

There is the possibility that extern companies can act as sponsors for the ITW with a minimum contribution of 25.000 € per year. Previous sponsors were for example “apetito Aktiengesellschaft” (AG), “Gelita AG” and “Hülshorst Feinkost”. For the “old” model from 2018 to 2020, in this thesis called ITW1, the main funding was organized by a fund that is financed by the participating food retailing businesses with 6,25 cent per kg sold meat, independently from the kind of meat. The amount was raised from 4 cent per kg sold meat in 2015 to the amount in force since 2020. The renumeration for fattening pig farmers accounted for 5,10 €/pig. Additional to the payment for the implemented measurements, a yearly tax-free allowance of 500 € was payed to the farmers to compensate the expenses implementing the basic requirements. The finance model for the program from 2018 to 2020 for fattening pigs is illustrated in Figure 4. Within the program phase between 2015 and 2018, in total 645 million Euros were available paying the participatory farmers implementing higher FAW standards from the catalogue of criteria (ITW 2020b, ITW 2020d). The reported amounts of meat form the calculation basis for the individual payment. At the end of the following quarter, the farmer receives his payment by the ITW.

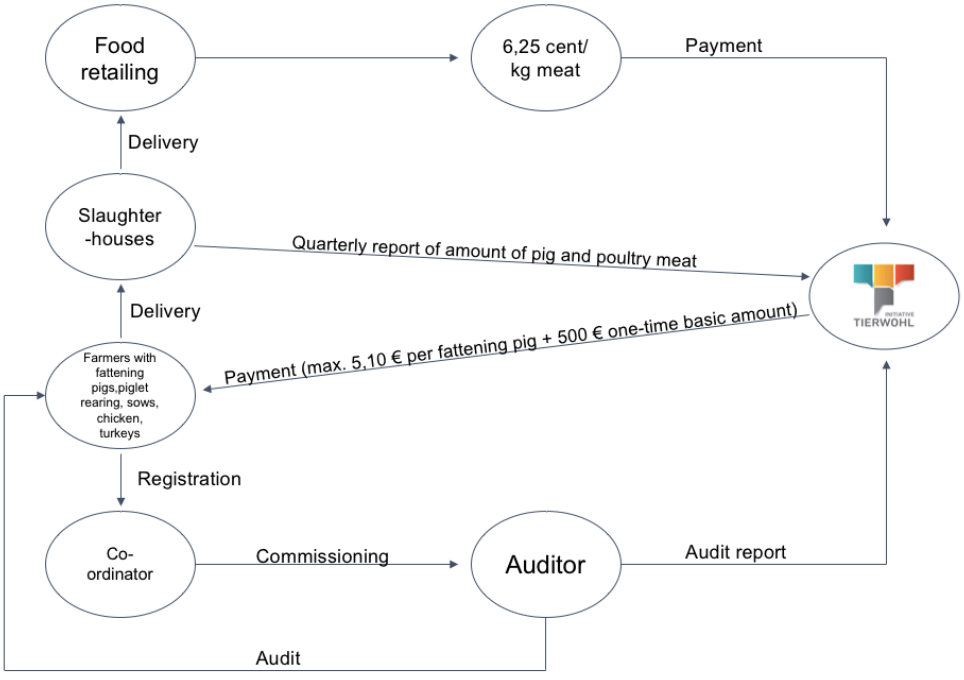
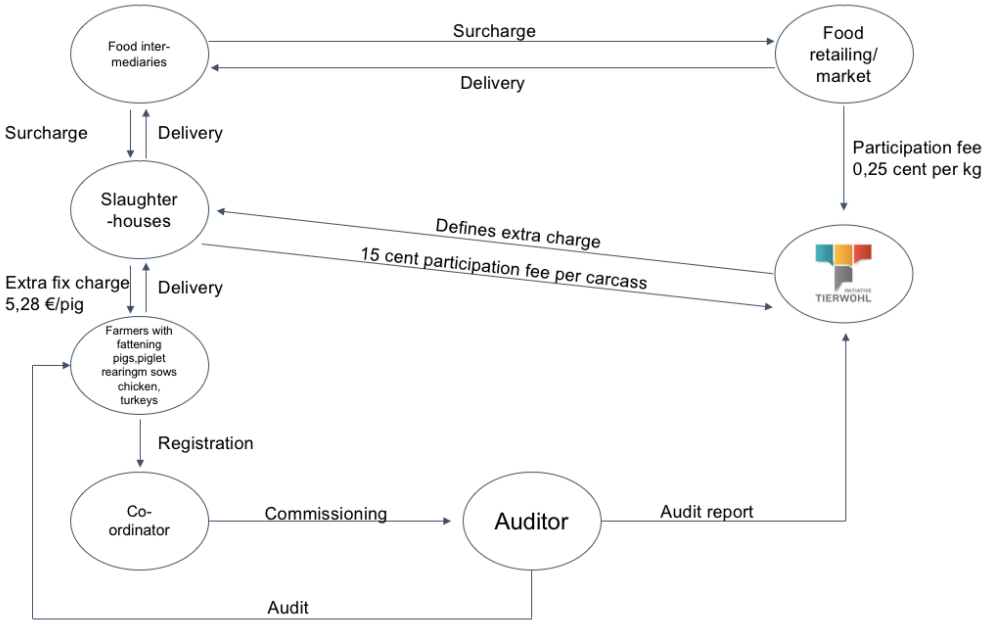


Figure 4: ITW1 finance model "fund model" for fattening pigs from 2015 to 2020 (own figure based on ITW 2020b; ITW 2020d; ITW 2020e)[14]

The finance model of the ITW changed for the third triennial program phase, started in 2021 and in this thesis defined as ITW2, with a development towards a more market-based one for the livestock farmers with fattening pigs, whereas farmers with piglet rearing and sows will be payed from a transition fund. Therefore, farmers with fattening pigs get an extra charge of 5,28 € per pig additionally to the market price. The extra price is oriented towards the determined average long-term costs for implementing the FAW standards of the ITW which are per se no additional costs on the products for the consumer because the participating food retailers cover the extra costs for implementing higher FAW standards. Participating farmers get the renumeration directly from the slaughterhouses which negotiate bilaterally with their buyers the surcharges. The food intermediaries have to negotiate bilaterally about the surcharges with the slaughterhouses on the one hand and the food retailing and market on the other hand. The new finance model, specific for fattening pigs, is presented in Figure 5.



[14] Logo “Initiative Tierwohl” available at: BMEL (2020)

Figure 5: ITW2 finance model "market model" for fattening pigs from 2021 to 2023 (own figure based on ITW 2020b; QS 2020)

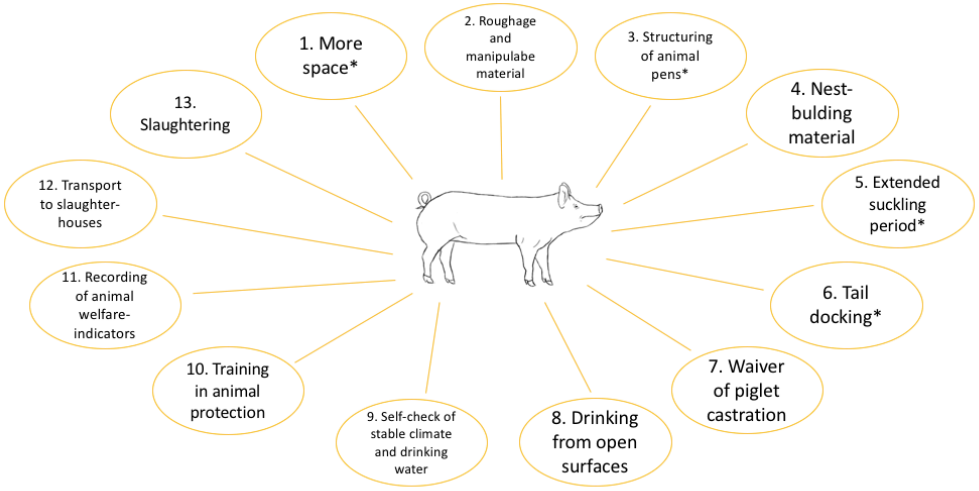
Furthermore, a unification of the previous FAW criteria is new without the option of additional selectable criteria for farmers with fattening pigs. The current applicable basic requirements (see Table A 2) will be mainly the same, except that the criteria “permanent access to roughage” becomes compulsory and the criteria “additional manipulable material” is not prescribed anymore. Continuously, farmers have to take part in a subject-specific training measure once a year (ITW 2020g). In Table A 3 the new criteria are illustrated. Also, a new feature is that meat from fattening pigs will be labeled from 2021 on (like poultry meat which was already labeled before).

The **coordinators** are acting as facilitators between willing farmers who want to participate and the ITW per se. The farmer has to choose an approved coordinator by themselves. The **auditors**, in total there are 83 auditors, are permitted by a sponsoring company of the ITW. Every participating farmer is monitored twice a year by an independent auditor, whereas two different audits exists. The “program audit” is very extensive, including checks of the documetns, and will be announced maximal 24 hours before. During the “inventory check”, which is unannounced, only the compliance of the selected criteria will be checked. The costs for the inventory checks are covered by the ITW. Further, every **farmer** is obligated to annually control the stable climate and the drinking water by an external expert. In case of non-compliance of the requirements of the ITW, additional special audits are mandatory. Within a whole triennial program phase, in total at least six audits will take place. Certification authorities coordinate the collaboration between the sponsoring company of the ITW and the participating farmers. Farmers with fattening pigs are still allowed to obtain piglets from operations not participating in the ITW (ITW 2020c). The participation in the ITW is possible for every **slaughterhouse** processing fattening pigs, chickens and turkeys which are certified by a quality assurance organization like with the QS-label. The participating slaughterhouses, presently overall 64 slaughterhouses, are obligated to inform the ITW quarterly about the slaughter quantities, and an external third party is liable to record the diagnostic data of the animals and report those to the QS-database. This is necessary for

developing an animal health index (Tiergesundheitsindex, TGI) which gains importance because conclusions about the condition of farm animals regarding respiratory health, health of organs, limbs health and integrity of the carcass can be made (QS 2020). The occurring costs for the procedures have to be covered by the slaughterhouses themselves (ITW 2019). The **food retailing businesses** have to be subject to an audit as well to check the identity of goods and correct labeling of products (ITW 2020c). The ITW aims at opening the system of the ITW for more sectors and partners. The payment will be made by the slaughterhouses which negotiate bilaterally the extra surcharge with the **food intermediaries**, consisting of cutting plants, meat wholesalers and marketers, which in turn negotiate with the food retailing and the gastronomy. To ensure the right usage of the ITW logo, the food intermediaries and slaughterhouses are subject of annual audits, too.

2.1.3.2 German animal welfare state label

The first German governmental FAW label is currently in the planning process and aims at labeling products where higher animal welfare standards than the legal minimum one in regard to animal husbandry, transport and slaughtering of farm animals are implemented. So far, there are only criteria[15] for fattening pigs which are illustrated in Figure 6.



* For those criteria there is a subdivision into three levels.

Figure 6: Criteria of the German Governmental Animal Welfare Label for fattening pigs (own figure based on BMEL 2020)

For some criteria there will be three different levels of FAW standards. For the first level, the space-criteria requires 20 % more space. Permanent access to roughage, manipulable material and opportunities for digging, have to be ensured for all levels, whereas for sows, nesting material has to be offered additionally. The stable has to be structured into different functional areas for all levels, e.g. installation of rubbing devices or interspersed lying areas. The suckling period is extended to 25 days, instead of 21 days, for level one. The option of drinking from open surfaces has to be implemented on all three levels as well. Further, farmers, employees in slaughterhouses and workers in the animal transportation business have to take part in training measures.

[15] A detailed explanation of the previous compiled criteria can be found at: https://www.topagrar.com/dl/3/3/0/6/4/6/3/Tierwohlkennzeichen_Kriterien_Tabelle_FINAL.PDF

The participation in the governmental label is voluntary but there will be a statutory framework. Regarding the reimbursement of the additional costs of farmers, the “Bundesministerium für Ernährung und Landwirtschaft” (BMEL) is planning to finance the label through a higher price for the labeled products on the market. Additionally, the BMEL plans to provide funding approaches for farmers (BMEL 2020). A detailed price calculation for the final product cannot be made until now. A comparable governmental FAW label is the Danish one “Bedre Dyrevelfærd”, which follows the same approach to improve animal welfare through consumer purchasing.

2.1.4 Funding of animal welfare production systems

Transformation processes towards more animal welfare-based systems are often linked to higher production costs on farmers side (Grethe 2017; Vetter 2014). The following Table 3 will give a short overview of the various options to finance improvements in animal welfare on plant level. The different options are listed regarding their degree of intervention in market mechanisms. The outlined instruments differ concerning their effectiveness, cost efficiency and distribution, political enforceability, administrative implementation and effects on international competitiveness and other bilateral commitments (WBA 2015).

Table 3: Governance instruments for financing farm animal welfare (Borchert-Commission 2020; FAWC 2008; Grethe 2016; WBA 2015)

Intervention in the market ↓

Governance instrument	Examples for instruments	Advantages of instrument	Disadvantages of instrument
Research promotion	E.g. RKI; Doctoral programs	Technical and institutional innovations; Provide information to policy	Coordination difficulties; May displace private sector initiatives
Training/ Advisory service	E.g. voluntary animal welfare check	Reduce societal problems; Improving competitiveness	Limited public funds
Monitoring and transparency	Collection and publication of animal protection data	Leads to objective debates	Complex collection of data
Industry agreements	E.g. ITW	Specialist function; Holistic perspective due to involvement of various stakeholders along value chain	Potential for narrow focus of responsibility; Risk of losses for participating parties when e.g. not all food retailers take part
Label	E.g. ITW; Neuland	More transparency; Increase in demand for products with more FAW	(Further) development of FAW-indicators; Too many labels lead to excessive demands on consumer side
Subsidies	a) Distribution-motivated, e.g. Second Pillar (CAP) b) Incentives, e.g. animal protection premiums	Available resources and budget	Limited budget; Conflict of interests with other financing necessities; Limited opportunities for national implementation in EU; Potential high administrative costs
Taxes/ Levies	Non-voluntary, e.g. increase of value added tax (VAT) rate from 7 % to 19 % or excise duty (quantitative)	Internalization of external effects; High tax revenues; Incentive to reduce consumption of meat; Low cost application	Difficult steering effect; Non-consumers of certain products have to carry costs; Disproportionate distribution of VAT rate shares for federal states in relation to different animal densities; Challenge of transfer excise duty from federation to federal state
Statutory standards	E.g. ban piglet castration without anesthesia	Nationwide minimum standards; Forceful	Limited efficacy due to far-reaching exemptions; High costs of implementation; Incentive to meet, not exceed
Controls and Sanctions	E.g. standard enforcement instructions; supra-regional specialist organs for control	Frequent monitoring	High costs; Risk of overly high level of control; Insufficient penalties

2.2 Pig production

2.2.1 Development of fattening pig production in Germany

In 2019, the German sector of agriculture, forestry and fisheries contributes with a percentage of 0,80 % to the German gross value added and with 1,30 % to the working population in Germany (DBV 2020). The sector reached a production value of 60,40 billion € whereby the proportion of animal products amounts for about 26,26 billion € (Statista 2020b). With an emphasis on the sector of animal husbandry, in recent years the net revenues for animal products are constantly increasing. However, since 2016 there is the trend of a decreasing production of meat in Germany. In particular, the declining production of beef and pork meat is the main reason for this development while the production of poultry meat is slightly increasing, even though pork is still the type of meat with the largest share, in total 56 %, of Germany´s gross self-production (DBV 2019).

The DBV (DBV 2019) indicates higher requirements and costs regarding environmental and animal protection as measurements for this trend. Another challenge is the African swine fever (ASF), where the first find of an infected wild boar in Germany was recorded in September 2020 (BfR 2020). In the second half of 2019, the problematic of the virus led to an immense price increase in pork meat in Germany due to the risen demand of countries with an acute outbreak of the ASF, especially China and Southeast Asia, combined with a shorter supply there. The DBV (2019) expects a decrease of circa 10 % of the worldwide pork production in 2020 compared to the previous year 2019.
The export of German pork meat increased about 2 % in 2019 compared to the previous year with the expectation of a similar trend in 2020. Thereby, about 70 % of the pork meat is exported within the EU, whereby Italy, Poland and the Netherlands are the main buyers. In 2019, the German self-sufficiency rate for pork meat accounted for 120 %.
The total pig stock in Germany accounts for about 25 million animals with a share of circa 7,8 million piglets, 4,6 million younger pigs under 50 kg without piglets, 11 million fattening pigs over 50 kg and about 1,5 million sows (Statista 2020a). The German pig business is strongly regional concentrated. Over half

of the German pig stock is kept in the old West German states, especially in Lower Saxony and North Rhine-Westphalia (BLE 2020a).

Looking at the structural changes, the amounts of farms with pigs decreased by 35 % within nine years from 2010 to 2019, whereas in the same period of time the whole pig stock in Germany only decreased by 2 %. Today, the approximate number of pigs is distributed on less farms, in total 20.400 pig farms. Particularly affected are smaller farms: in 2010 about 4.200 farms with pig stocks under 100 animals existed, in 2019 the number declined to 1.700 farms. Simultaneously, the quantity of farms with 500 to 999 pigs decreased by 32 % and such with pig stocks over 2.000 animals raised by 35 %. The cattle farming sector is characterized by a similar development (Statistisches Bundesamt 2020). The described development is illustrated in Figure 7.

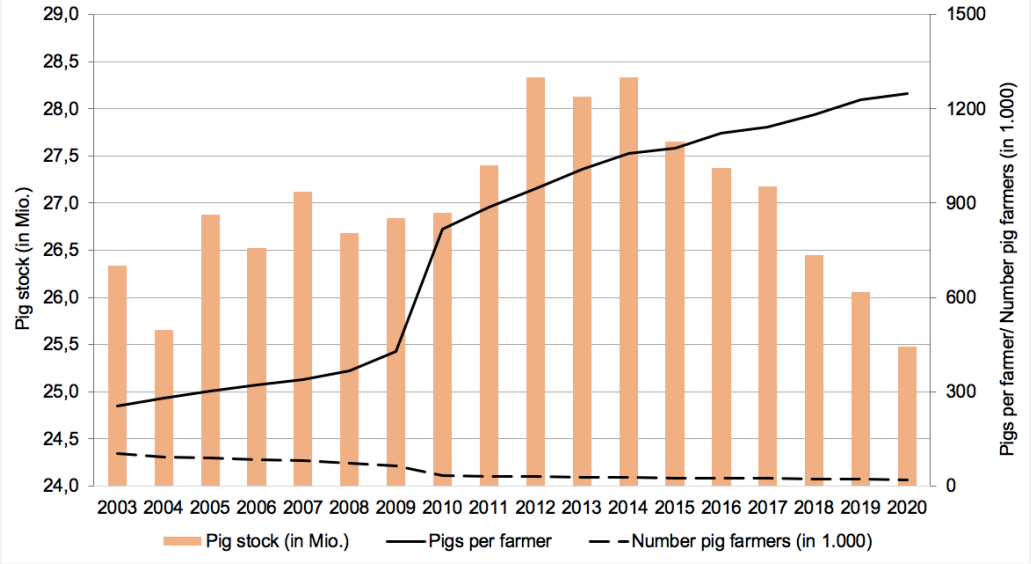


Figure 7: Development of the German pig sector from 2003 to 2020 (own figure according to Statistisches Bundesamt 2019)

This structural transformation is a process which is part of the discussion of FAW because correlated questions occur like ´Does herd size matter for an appropriate animal welfare standard?´ or ´How to ensure low emission rates with pig stocks over 2.000 animals in free-range husbandry systems?[16]´

The todays pig farming business is characterized by a progressive specialization, mainly characterized by the principle of cost leadership (Lüth & Spiller 2006). Against the background of maximizing productivity and profitability and optimizing the production efficiency, the livestock production sector focus´ on the establishment of intensive animal rearing conditions like indoor housing with minimum space to maximize production. Besides the benefits offered by those systems, e.g. controlled emissions, good hygiene and health control, they are associated by society with negative impacts on FAW (Napolitano et al. 2010). Many farmers concentrate their business on one or two types of production. The different types of production include breeding, gilts rearing, piglet rearing and fattening. On processors side, there is a clear trend towards a vertical specialization. The biggest slaughtering businesses in the sector of meat and processed meat are the Tönnies Holding at the first place with around 16 million slaughtering and a turnover of 6,65 billion € in 2019, followed by the Vion Food Group and Westfleisch with around 7 to 8 million slaughtering. Those three companies apportion a market share of 57 % in Germany (Statista 2020c).

[16] There is a need for further comprehensive research regarding odour, carbon dioxide and ammonia emissions in free-range husbandry systems. Several studies show potential of stables with an open construction and outdoor climate stimuli to fulfill current emission thresholds while providing more animal welfare compared to closed stables with forced ventilation (Bauer et al. 2019; Rösemann 2015).

2.2.2 Husbandry systems for fattening pigs

With a share of 92 %, the dominating husbandry systems for fattening pigs in Germany are fully slatted and partly slatted floors, followed by perforated floors with litter and a small share of free-range husbandry, mainly implemented by ecologically working farms (Rohlmann & Efken 2020). Figure 8 will give an overview of the various husbandry systems which are possible for fattening pigs, in the first place classified into systems regarding the functional area, with a separated or a combined resting and activity area, and then regarding the use of straw, the ground conditions and the possibility of outdoor climate access. The functional areas for resting, eating and activity, are chosen by the animals themselves but can be structurally controlled as well. Thereby, various combinations and variations of the different systems are possible, for example the husbandry system with slanted floors can be indoor with forced ventilation as well as combined with yards or only with outdoor climate access. Another classification can be made regarding the size of the group, small and large group stables, indoor versus outdoor systems or the choice of the feeding method. In recent years, especially stable constructions with outdoor climate access gained more and more importance in practice (BLE 2020c).

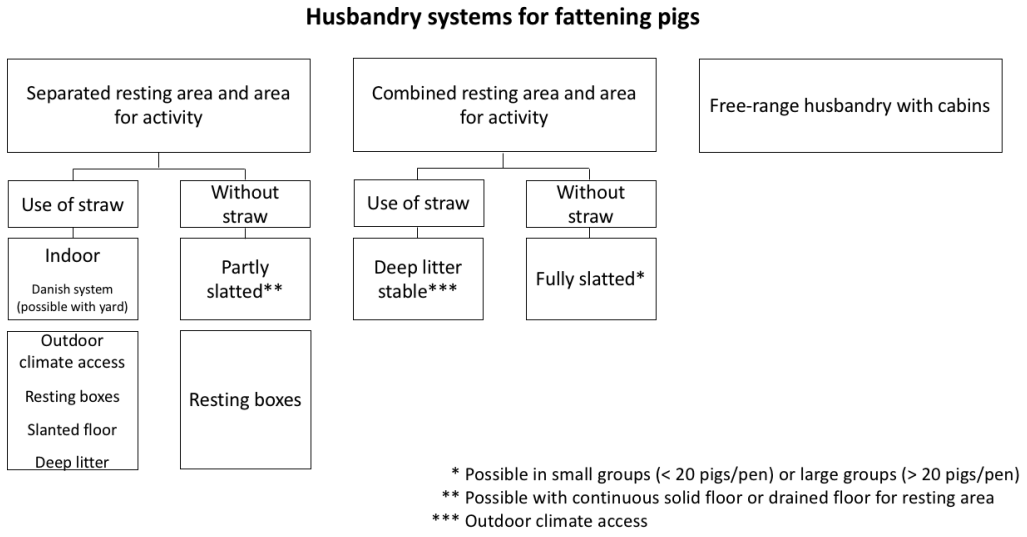


Figure 8: Potential classification of different husbandry systems for fattening pigs (own figure following Hoy et al. 2016)

Alternative husbandry systems, like stables with yards, outdoor climate houses, deep litter systems or non-slatted floors with bedding and periodical removal of manure, are often difficult to realize because the database regarding their emissions is insufficient for political decisions. The present state of knowledge states that more animal welfare-oriented husbandry systems with yards, especially those with litter and no roofing, have difficulties to fulfill odour, ammonia and carbon dioxide emission requirements in comparison to closed stables with forced ventilation (WBA 2015). However, studies and practical examples show a potential of stables with open construction and separated functional areas with a defined feces area and the separation of feces and urine in regard to lower emissions, even higher than in the classical stables with forced ventilation (Amon et al. 2005; Bauer et al. 2019; Heidinger & Zentner 2017; Pflanz & Jungbluth 2007). On the other hand, the additional offer of a yard can reverse these positive effects because the ground-level release of emissions can lead to stricter regulation in terms of distance to housing estates (Neser & Grimm 2019).

2.2.3 Problem areas of conventional fattening pig production regarding animal welfare

In the societal debate about FAW in the pig sector, the main points of critique are the dominating types of husbandry systems like closed stables with fully slatted floors, use of medicinal products, indirect land use effects and resource consumption, and the spatial concentrations of livestock linked to concerns about stock sizes and manure surpluses (Borchert-Commission 2020; Spooner et al. 2014; WBA 2015). Two of the most important implementation measures for higher FAW in pig farming are the structuring of the area like diversified floors with for instance straw as bedding material or the establishment of climatic stimulants, combined with more space for the singular pig, for sows as well as for fattening pigs, and the use of manipulable materials which can as well minimize the risk of tail biting (Wallgren et al. 2019; Ziron 2018). The difficulty of higher use of bedding material may lead to a floating area on the manure surface which can impede the manure outflow (Feller 2019). Under 2.2.2, the conflict of stables with outdoor climate access was already presented.

Further, society and scientists make the adaptation of animals towards their husbandry environment a subject of the discussion which means in detail criticizing the castration of piglets without anesthesia, which is prohibited since 2021, crate stands for sows which are under current revision, and the tail docking of fattening pigs (Borchert-Commission 2020). The general high-performance level in the pig sector is criticized as well, e.g. against the breeding aim of a high number of born piglets, up to thirteen weaned piglets per sow, on average 2.32 litters per sow and year and averagely 2.80 rotations per year in the fattening pig sector (Rohlmann & Efken 2020). High-performance levels can have an impact on the robustness and health of animals, e.g. lameness due to claw and joint damages or behavioral disorders, whereby the husbandry environment can act as an opponent, for instance decreasing the share of slatted floors (Agrarheute 2015).

A study showed, that in the course of consumer protection, some parts of society perceive a high use of veterinary medicinal products which they link to the problem of large stock sizes and the antibiotic-resistance problem (Feller 2019;

Simons & Christoph-Schulz 2019). Over-use and misuse of antibiotics in animals can contribute to the risk of emergence of resistant bacteria that can be transferred to humans through the food chain or direct contact (European Medicines Agency 2021; Lindmeier 2017). Active ingredients of medicinal products can get through manure or sewage in soils and the groundwater, from there again, residues can be absorbed by plants which are further used as food or feed or which can contribute to the development of resistances due to changes of the soil flora (WBA 2015). These developments are united in the so called “one health” - perspective which considers the effects of antimicrobial use in humans, animals and the environment as well as the spread of resistant bacteria between these environments (McEwen & Collignon 2018). After the “Umwelt Bundesamt” (UBA 2018), an extensive pollution of the groundwater due to medicinal products can be precluded.

The transport duration of animals to slaughterhouses in regard to FAW is perceived negatively by parts of the society as well (Heise 2016). Due to the concentration of the slaughtering industry as well as of the pig farming, longer distances and more frequent transports, carrying the animals from the farm to the slaughterhouse, have to be bridged (BLE 2021a).

2.2.4 Risk in livestock production

Every entrepreneurial activity is connected to risks which result out of the uncertainty about future events (Frentrup et al. 2014). This means, that the factors relevant for business success, for example prices or yields, are random variables which can assume different future values. Because of the uncertain variables, relevant for the business success, the business success itself becomes a random variable whose future value cannot be predicted for sure (Hirschauer & Mußhoff 2016). If the farmer has no specific knowledge about the income level but information about the probabilities of occurrence of the various assumable values of the random variables, decisions are taken under risk (Hirschauer & Mußhoff 2012). Every risk involves the chance to participate in (unexpected) positive developments for the individual farm, whereby a completely avoidance of all entrepreneurial risks is considerable impossible (Hotwagner, 2008).

Especially agricultural businesses have to deal with diverse risks, also due to the dependence on natural uncertainties in the production process. In recent years, several structural changes in the livestock sector, assessed as sources of risk, effect a lack of information, which raise the question of hedging the interlinked impending consequences. Sources of risk for an operation can be divided, according to Hirschauer & Mußhoff (2016), into business risk and financial risk. The latter one occurs in particular when having factors which need a fix renumeration, such as paying rent or salary. The higher the usage of non-business factors of production, the higher the financial risk. The business risk includes price risks, volume risks, as for example risks caused by the weather or by pests and diseases, behavioral risks like quality risks when purchasing production means, and institutional and technological innovation risks. The general uncertainty about decisions on agro-political level in the EU as well as in Germany, for instance the new “TA Luft”[17] or the stricter fertilizer ordinance (BLE 2021b) and for the slaughter industry the new decided law to prohibit service contracts and temporary worker contracts in the sector of slaughtering,

[17] The Technical Instruction on Air Quality Control (TA Luft) is the German central set of regulations to reduce emissions of air pollutants caused by plants with a need for licensing (BMU 2020).

preparation of cuts and meat processing (Deutscher Bundestag 2019), are examples for innovation risks. These risks, as well as the change of nutrition trends, for example the consumption of vegetarian and vegan alternatives increased during the last years (BMEL 2020b), strongly fluctuating piglet and pig prices mainly due to the general market liberalization, the increased volume risk caused by the climate change, the in 2020 global arised Corona-crisis and the last years intensified onset of the ASF can be currently seen as main sources for risk in the German livestock sector.

According to Barry et al. (2001), there will be greater fluctuations of agricultural incomes. Recently, the interest as well as the importance for a systematic risk management for agricultural enterprises increased in Germany (Offermann et al. 2017; Schaper et al. 2012). For one thing, an aimed risk management includes measures to reduce unacceptable fluctuations of the business success, then again it provides a basis for decision-making for strategic considerations about several action alternatives (Frentrup et al. 2014; Hirschauer & Mußhoff 2012). Risk management is a continuous, adaptive process which has to be passed through all the time. There are existing several phases of the process: risk identification, risk assessment, risk governance and risk control (Hirschauer & Mußhoff 2016; OECD 2009). Further, risk management should be an integral part of a firm´s good management (Hardaker et al. 2014).

There are several risk-management instruments which in the narrow sense all costs money and in a broader sense can contribute besides risk reduction to increases in income. Internal risk management instruments, where solely the farmer is involved, include strategies for diversification, e.g. backward integration of a fattening pig farmer by starting piglet production, creation of safety buffers, for instance establishing storage facilities for grain, and reduction of negative fluctuations of risk factors relevant for the success, e.g. installation of irrigation systems as an instrument for controlling the environment. External risk management instruments include the market mechanism. Price based external instruments are bilateral forward contracts and commodity future transactions, in each case including futures and options. Quantitative instruments are indemnity insurances, e.g. hail insurance, and index insurances (Hirschauer & Mußhoff 2012; Van Winsen et al. 2014).

2.3 Farm case

The description of the analyzed farm will be kept shortly due to reasons of anonymity. The underlying farm case includes the three business segments: arable farming, pig fattening and the operation of biogas plants. The subject of investigation is the farm´s pig fattening business with which the farm is participating in the ITW1 since April 2018, and now is participating in the third program phase ITW2 from 2021 to 2023 (Farm manager 2020). The general description of the firm´s pig fattening operation is illustrated in Table 4 and the key figures of the biological performance are presented in Table 5.

Table 4: Description of the analyzed firm´s pig fattening operation (own table based on Farm manager 2020)

Pig fattening	
Animal places	10.400
Sections	32
Livestock areas per section	20
Animals per livestock area	18 (> 50kg)
Stable construction	Closed stable Fully slatted floors Forced ventilation
Feeding method	Liquid feeding
Manure handling system	Liquid manure system

Table 5: Biological performance of the analyzed firm´s pig fattening operation (own table based on Farm manager 2020)

Biological performance		
Characteristic	**Unit**	**Value**[a)]
Stalling-in weight	kg	28,80
Final fattening weight	kg	122,60
Feed conversion 1:	kg/ kg growth	2,72
Feed intake	kg/ pig/ day	2,19
Daily weight gains	g/ pig/ day	845,00
Fattening period	days	112,00
Rotations	Rotations/ year	2,90
Losses (dead animals)	%	2,80
Lean meat content	%	57,40
Slaughter value index	%	78,00
Liquid manure	m^3/ animal place/ a	2,00

[a)] The values represent the average biological data of the farm case from 2013 to 2019.

The implementation of the required measurements for the ITW1 started in January 2018, the officially participation began in April 2018. The criteria implemented by the farm are the basic criteria and the facultative criterion of supplying permanent roughage, see Table 6, which results in a payed animal welfare remuneration of 5,10 € per registered and slaughtered pig and an annual 500 € tax-free allowance per location.

Table 6: Implemented ITW1-criteria by the analyzed farm (own table based on Farm manager 2020)

Basic criteria	
QS-antibiotics-monitoring	According to QS-guidelines
QS-slaughtering results	According to QS-guidelines
Stable climate check	Annual standardized check
Drinking water check	Annual standardized check
Daylight	Minimum of 1,50 % of the house floor area has to be a translucent surface for daylight
Additional manipulable material (photo in Appendix 1)	Modifiable; Minimum relation 1:20 animals with a space of minimum one pig wide between the materials (wooden blocks at a chain)
10% more space	0,825 m^2/ pig
Facultative criteria	
Roughage (photo in Appendix 1)	Permanent access; Feed dispenser with straw pellets; Different material than manipulable material; Separate offering from manipulable material

3 Methodology: on farm-study

Hereinafter, the used data and applied methods will be described, all based on the analyzed farm. Thus, it should be noted that from the applied methods and resulted outcomes no general statements for other farms can be made because the data is often company specific. Nevertheless, the aim is to generate meaningful results about the profitability of animal welfare in the fattening pig sector. Because for reasons of anonymity, the farm manager as well as the location of the analyzed farm will stay anonymous.

First of all, the methodology of a qualitative interview and the analysis of the responses of the farm manager will be explained. The statements of the farm manager allow a first valuation of possible risks in the fattening pig business in the agricultural sector. Subsequently, the procedure of the business segment accounting will be presented. The business segment accounting forms the basis for the analysis of the effects of the participation in the ITW1 and based on this for the competitor analysis regarding the firm´s direct cost-free performance. In section 3.3 the method of calculating the extra costs of the ITW under three different animal welfare scenarios will be explained. Therefore, the ITW1 within the program phase from 2018 to 2020, the new ITW2 program phase from 2021 to 2023 and scenario of the planned German animal welfare state label are compared with each other. Further on, part of the extra-cost accounting will be a threshold calculation of the loss of contribution margin to determine the threshold at which the payments are not covering the extra costs of implementing higher animal welfare requirements. After that, in section 3.4 the approach of the risk analysis will be clarified. There are three main approaches to develop a risk profile: the historic simulation, the analytic analysis (variance-covariance method) and the stochastic simulation. Here, the simulation approaches, historic and stochastic simulation, will be carried out and compared among each other. Additionally, in the subsection 3.4.1 the profitability of the ITW1 will be further analyzed under different price scenarios depending on slaughter revenues, piglet costs and feed costs. Therefore, a statistical analysis of the prices is necessary to examine possible price correlations and price developments.

3.1 Analysis of farm case: qualitative interview

With regard to research question one of this thesis, a methodological approach via qualitative oriented empirical social science was chosen (Mayring & Fenzl 2014). The chosen survey method is a guideline-based expert interview. The gained data will be analyzed with the qualitative content analysis according to Mayring (2015). The qualitative oriented approach allows an explorative gathering of the statements, which means to analyze the content against the background of limited knowledge about the relationships of the data. In comparison to quantitative methods, the focus of qualitative approaches is on gathering detailed information of individual attitudes, assessments and expectations (Heise 2016). Further, the qualitative interview was appropriate for this thesis because the object of investigation is an agricultural farm and the statements of the appendant farm manager will lead to more context-specific information and it allows a classification of the analyzed economic data against the background of the farmer´s operational development plans and assessed current risks.

The guideline-based expert interview is according to Witzel (1985) a problem-centered interview with two main characteristics. Firstly, it is semi-structured which means that the questioner is oriented towards an interview guide which he designed based on the theoretical background to be examined. On the other hand, the interview is open, so the respondent can answer freely.
The guided interview is characterized by its survey method, a guideline, whereas expert interviews are marked by their specific target group of respondents. Experts, chosen by their status, can act as advisors or knowledge mediators who pass factual and empirical knowledge along, which allows an uncomplicated transfer of information. The expert of this interview is the farm manager of the examined farm who is faced with questions regarding the risk management on operational level and the assessment of current challenges in agriculture, particularly in the fattening pig sector.
The in advance prepared guideline is a systematic applied specification for designing the interview procedure. The guideline can be created in various ways with the following optional elements: requests to speak, explicit pre-formulated questions, keywords for free formulated questions and/ or special agreements

for handling the interaction of certain phrases of the interview (Helfferich 2014). One main advantage of guided interviews is to allow a maximum openness, so all possible statements can be made. Usually, a certain degree of controlling the communication situation is necessary. In this context, the underlying guideline is based on open questions which were prepared in a strict order before. The interview guide is divided into two thematic sections. The first section deals with questions about risk management, more precisely about implemented risk management tools and the personal evaluation of their effectiveness. The second part contains questions about current challenges which have to be faced in the fattening pig business, their categorization regarding probability of loss and amount of damage and about future operational development opportunities in form of a risk matrix. It should be noted that the gained qualitative data represents the subjective evaluation of the farm manager. The interview took place face-to-face with the farm manager on the 18.05.2020. Before the interview, a permission was obtained from the respondent to audio-record the interview. At the same time, the questioner agreed to anonymize the personal data.

Subsequently, the interview was transcribed by means of the rules according to Dresing & Pehl (2018). This transcript procedure allows a literal transcription while linguistic peculiarities like grammatical errors, are not important for the analysis of the content. Because of the singular interview and no other interview or analyzed farm to compare with, it is not possible to derive general statements out of the data material. Further, interviews are vulnerable to distortion and influence through the interviewer (Bogner et al. 2014).

3.2 Business segment accounting

A business segment accounting, in this case of the fattening pig business, is defined as the representation of performances (plus public direct payments) and costs of a business segment and associated monetary and natural supplementary data (DLG 2004).

The establishment of a business segment accounting has two purposes: a past-oriented post calculation, which was carried out in this thesis, and a forward-looking preliminary calculation. The preliminary calculation focus´ on individual planning as well as on price calculations. In comparison to that, the post calculation aims to carry out an individual control of a firm´s profitability including the analysis of weak points. If possible, all performances and costs, in total the full costs, of a business segment form the basis for the calculation. The full-cost accounting discloses unit costs per unit of production, here in the case per kg carcass weight and per fattening pig (DLG 2004; Hirschauer & Mußhoff 2016).

The established accounts for the different fiscal years are oriented towards the cost breakdown of the DLG (2004). An exemplary scheme of the utilized business segment accounting is illustrated in Table A 4. The presentation of performances and costs can be made with the total cost method or the cost of goods sold method. In case of the total cost method, all performances of one period are contrasted with the total costs, so that the expenses from the financial accounting can be directly transferred. Whereas at the cost of goods sold method, only the costs of the sold products are subtracted from the revenues of the sold performances (products). In this case, the total cost method was used in consideration of the fact that the higher the inventory changes caused by the all-in all-out system for fattening pigs, the higher the deviation of the reference value €/kg carcass weight from the actual conditions. That is why the reference value €/fattening pig is used additionally (Coenenberg et al. 2016; DLG 2004).

Incidental costs within the fattening pig business are assigned to certain types of costs: factor costs[18], direct costs, employment-related costs, building costs

[18] Factor costs are determined by the farmer or the consultant (DLG 2004) and are defined as costs which occur for production factors (work, soil, capital) as an economic countervalue for their usage in the production process (Weizsäcker 2021).

and other costs. Furthermore, the recognition of other types of costs is possible depending also on the examined business segment, for instance lease costs arise specifically in arable farming business. The outlined types of costs can be direct allocable as well as overhead costs whereas the latter ones are defined as costs which are not direct allocable to one singular costing object and therefore not explicit assignable (Hirschauer & Mußhoff 2016). There are existing several principles for break down overhead costs. According to Hirschauer & Mußhoff (2016), the subordinated cost-allocation methods impact principle, the principle of average and the carrying capacity principle are the appropriate ones for breaking down those costs for the full-cost accounting of the business segment. The principles are used by their degree of justification, whereby the impact principle has to be used first, followed by the principle of average. Nevertheless, it should be noted that every cost-allocation is subject to arbitrariness, depending on the cost allocation method and the accuracy of the data source. In addition, to derive changes of performances and costs caused by certain entrepreneurial decisions is difficult due to proportionalized costs which might not be influenced by the end product directly.

The business segment accounting targets to analyze the effects of the firm´s participation in the ITW1 with its direct-cost free performance, the profit and the computational result of the business segment. These results will be compared to the situation without implementing the ITW1 requirements and to results of other test operations, for example with results of the annual published pig report of the Chamber of Agriculture Schleswig-Holstein. For analyzing the effects of the ITW1 for the firm, the variable direct cost-free performance was used because it is on the one hand an appropriate value to control the efficiency of the production and on the other hand a suitable target figure to compare with other test operations (DLG 2004). The direct cost-free performance is defined as follows:

$$Direct\ cost\text{–}\ free\ performance\ (Dcfp) = Performances^{19} - Direct\ costs^{20}$$

Formula 1: Direct cost-free performance

The performances consist of sales revenues from fattening pigs and piglets at times, the ITW1 renumeration payment, inventory changes and other operational earnings. Direct costs include all direct to the fattening pig business segment allocable costs which are listed in Table A 4. For the scenario without ITW1, the higher amount of fattening pigs, resulting in higher costs for piglets and feed, was considered appropriately.

[19] Performances are defined as „monetary value of all goods and services generated during typical operational activities" (Hirschauer & Mußhoff 2016: 68).

[20] According to Hirschauer & Mußhoff (2016), variable costs in the agricultural practice in Germany can be further divided into direct costs, which refer to the monetary consumption of resources for seeds, fertilizer and plant protection, and variable employment-related costs (variable machinery and labor costs including contractors costs).

3.3 Extra-cost accounting of animal welfare scenarios

The extra-cost accounting was carried out for three different animal welfare scenarios which are presented in Table 7 and only considers the cost side of animal welfare, not the savings. For the scenario of the German animal welfare state label, the displayed requirements and assumptions are based on the so far published concept from the BMEL and a fictitious value for the remuneration was chosen, oriented towards the payment of the ITW, because the details of the prospective label are still in process (BMEL 2020a).

Table 7: Animal welfare scenarios for extra-cost accounting (own table based on BMEL 2020a; ITW 2020c; ITW 2020g)

	ITW1 2018 - 2020	ITW2 2021 - 2023	State label (Level 1)
Fattening places[1)]	27.144		24.128
Space [m^2]/ pig	0,825		0,90
Requirements for stable structure	10% more space Roughage Additional manipulable material[2)]	10% more space Roughage	20% more space Roughage Additional manipulable material[2)] Pellet dispenser Drinking from open surfaces Rubber mats Rubbing option
Renumeration [€/pig]	5,10	5,28	6,00[3)]

[1)] The reference are 10.400 animal places with 2,90 rotations/year (Farm manager[21] 2020).

[2)] Additional to the legal minimum standard.

[3)] The payment of 6,00 €/pig is based on own assumptions.

The data basis for the calculations form the animal places and price information of the examined agricultural firm, the animal welfare requirements published on

[21] Farm manager (2020), personal interview, 2020-05-18

the websites of the ITW and the BMEL, the price data from suppliers of stable material and key figures like average hourly wages or working time requirements, offered by the KTBL (2016; 2014).

The extra-costs for implementing the listed requirements in Table 7 are defined as follows:

$$Extra\text{–}costs\ of\ higher\ AW\ standards\ \left(\frac{€}{pig}\right) = Loss\ of\ CM + Annual\ investment\ costs$$

Formula 2: Annual extra-costs of higher animal welfare standards

The annual investment costs for each requirement, which vary between the different FAW scenarios, include:

$$Annual\ investment\ costs\ \left(\frac{€}{pig}\right) = Annual\ material\ costs^{22} + \text{Annual labor costs}^{23} + \text{Annual audit and managing costs}^{24}$$

Formula 3: Annual investment costs

The disclosure of singular investment costs for each requirement will be made as well:

$$Singular\ investment\ costs\ \left(\frac{€}{pig}\right) = Purchase\ price\ including\ installation\ costs * Amount\ of\ installed\ devices$$

Formula 4: Singular investment costs

[22] Annual material costs include for instance the material for filling up the roughage and pellet dispenser and replacing the wood pieces at the chain (additional manipulable material).

[23] The extra working time for maintaining the requirements, like restocking the dispensers or cleaning the installed devices for drinking from open surfaces, are examples for annual labor costs. The labor costs for the installation of the requirements are not part of these annual costs but belong to the singular investment costs because they arise one-time.

[24] The annual audit- and managing costs encompass costs like the checks for stable climate and drinking water quality, costs for planning and organizing the participation in the program, costs for monitoring the antibiotics usage and employee training.

The loss of revenues caused by the lower amount of fattening pigs due to the space requirements was considered by the key figure loss of contribution margin (CM). For the calculation of the loss of CM, an average value of the losses of CM from 07/2007 to 08/2020 was determined for each FAW scenario. Therefore, for each month the loss of contribution margin with the respective space requirements (see Table 7) was calculated. The figure CM is primary used to cover the fix costs of an operation and contributes to the realization of profits. The contribution margin is according to Weber et al. (2016) defined as follows:

$$Contribution\ margin = Variable\ performances^{25} - Variable\ costs^{26}$$

Formula 5: Contribution margin

The variable performance consists of the term carcass weight in kg (x_{pig}) multiplied with the market price p_{pig} in €/kg carcass weight. The variable costs consist of the piglet costs, with x_{piglet} correspond to 28 kg piglet weight as a reference multiplied with the piglet price p_{piglet} in €/28 kg, and the feed costs with the amount of feed in kg (x_{feed}) multiplied with the price per kg feed p_{feed}. The price data is taken from the AMI (2002a – 2020a), AMI (2002b – 2020b) and the BLE (2020b). For the value carcass weight, the average measured value of the carcass weight of the analyzed farm is taken. The calculated amount of feed per pig is as well based on data of the analyzed farm.

The above-mentioned CM was chosen to calculate with because the figure contains the main relevant variable costs of the fattening pig business for which a relatively long time series of prices from 07/2007 to 08/2020 exists. This allows a representative establishment of an average for the loss of contribution margin. In addition, the figure is easy to calculate and intuitive interpretable. A qualification must be made to this procedure in that the used formula does not include all incidental variable costs like water wastage, variable machinery costs, animal insurance or veterinarian costs, which can change with lower numbers of kept animals. This will be for the sake of simplicity neglected because only the relation between the largest variable costs, the purchase of piglets and feed,

[25] Variable performances are performances which can alter with the change of production (Hirschauer & Mußhoff 2016).

[26] Pursuant to Hirschauer & Mußhoff 2016, variable costs depend on the scope of production, including for instance costs for feed or seeds.

additionally to the extra-costs implementing the animal welfare requirements will be compared to the payed remuneration.

To estimate at which loss of CM the payed renumeration will not cover the extra-costs, a threshold of lost CM, based on the time series at different pig-, piglet- and feed-prices, was calculated. The generated statement at which point the renumeration does not cover the extra-costs of implementing the FAW criteria in Table 7 is extended by the likelihood of occurrence of the threshold during the times series 07/2007 to 08/2020.

3.4 Risk analysis at farm level

Since, according to Hirschauer & Mußhoff (2016), Frentrup et al. (2014) and Hardaker et al. (2004), business decisions are always taken under uncertainty, the following sub sections are dealing with the assessment and targeted management of entrepreneurial risk. Finally, the aim is to design the uncertain cause variables in that way that the scattering of the target figure is reduced. There are two main approaches within the risk management: the qualitative risk management, based on subjective expert assessments, and quantitative risk management which rests on statistical analysis. Hereafter, the focus will be on the quantitative risk management, more specifically on the identification of the probability distribution of the uncertain cause variable as well as creating a risk profile of the relevant target figure without and with implementation of a risk strategy based on statistical analysis. The approaches within the quantitative risk management are the historic simulation, the variance-covariance method and the stochastic simulation. The used methods will be the historic and stochastic simulation because the variance-covariance method requires a normal distribution for all additive linked uncertain variables. For the simulation methods a non-perfect normal distribution of all uncertain variables is assumed, according to the central limit theorem. To create a risk model, an operational planning model, where the probability distributions of the risk factors are the input and the probability distribution of the targeted figure is the output, is necessary as well as to display the causal relation between the uncertain cause variables and the targeted figure (Hardaker et al. 2004; Hirschauer & Mußhoff 2016). The whole risk analysis was made by means of the spreadsheet program Microsoft EXCEL.

According to the central limit theorem, a non-perfect normal distribution for the simulation of the price data is presumed, because the sum of several random variables of arbitrary distributions converge against normal distribution (Hirschauer & Mußhoff 2016). For a further usage of the price data, the correlation between the prices of fattening pigs, piglets and feed, which represent the uncertain cause variables, will be tested at first. Then, the methodical approach of the historic and stochastic simulation will be depicted, followed by the description of the price scenario analysis.

3.4.1 Correlation of prices

To identify potential correlations between the fattening pig prices, the piglet prices and the prices for feed, the relation between these random variables will be examined stochastically. The level of the correlation of quantitative attributes can be measured with the Pearson correlation coefficient (Spilke & Wensch-Dorendorf 2017). This coefficient is scaleless and is between minus one and plus one. The Pearson correlation coefficient $\rho_{k;l}$ is defined as the "quotient of the covariance and the product of the standard deviations of the random variables X_k and X_l" (Hirschauer & Mußhoff 2016: 390):

$$\rho_{k;l} = \frac{\sigma_{k;l}}{\sigma_k \times \sigma_l} = \frac{s_{k;l}}{s_k \times s_l}, with\ \sigma_k, \sigma_l, s_k, s_l > 0$$

Formula 6: Pearson correlation coefficient

The covariance is in the formula characterized with $\sigma_{k;l}$ depending on the random variables X_k and X_l. The term $s_{k;l}$ marks the covariance of the samples, whereby the covariance is estimated out of a sample. If the correlation coefficient amounts to $\rho_{k;l} = 0$, there is not correlation between the two random variables. Whereas a completely correlation of the two variables is given at $\rho_{k;l} = 1$. If the two variables shift in total opposite directions, they are both negatively correlated $-1 \leq \rho_{k;l} \leq 0$ (Henze 2019; Hirschauer & Mußhoff 2016). The calculation of the Pearson correlation coefficient was made using the EXCEL-function PEARSON. The period of time to examine the correlations between the price variables encompass the months between 07/2007 to 08/2020. With this time series, which describes according to Kreiß & Neuhaus (2006) a sorted sequence of real quantities, temporal trends and/ or seasonal influences can be represented. The aim is to adequately describe interdependent data chronology.

3.4.2 Historic simulation

The historic simulation as well as the stochastic simulation are numerical methods. The historic simulation is the easiest one to apply out of the quantitative risk management methods with the condition of having a large number of observed values of the uncertain variables without structural breaks (Hirschauer & Mußhoff 2012).

To establish a historic simulation, the following sequential steps according to Hirschauer & Mußhoff (2012) were followed:

1. Determination of the action alternatives to be analyzed

The action alternatives, specifically the analyzed scenarios for which the historic simulation was done, are presented in Table 8.

Table 8: Overview of FAW scenarios for historic simulation (own table based on BMEL 2020a; ITW 2020c; ITW 2020g)

	Without ITW before	**Control**	**ITW1**	**ITW2**	**State label (Level 1)**
Initiator	-	-	"Initiative Tierwohl"		BMEL
Practical realization	-	-	2018 – 2020	2021 – 2023	In process
Analyzed time period	05/2015 – 12/2017	01/2018 – 08/2020			
Data basis	Farm case (10.400 animal places; 2,90 rotations/year)				
Requirements	none	none	10% more space		20% more space
			Roughage	Roughage	Roughage
			Additional manipulable material		Additional manipulable material
					Pellet dispenser
					Drinking from open surfaces
					Rubber mats
					Rubbing option
Renumeration	none	none	5,10 €/pig	5,28 €/pig	Own assumption: 6,00 €/pig

The analyzed time period from 01/2018 to 08/2020 was chosen because the examined farm started participating in the ITW1 in 01/2018. Therefore, the

“control scenario” was chosen for the same time period. The scenario “without ITW before” was defined as a comparative scenario to the other ones for the time before the ITW which is why the time period of 32 months before the start of the ITW program phase, also amounts to 32 months, was taken.
Further on, the participation in a FAW program, here in the ITW and the German state label, is seen as a risk strategy with constant prices paid independendly from the market prices for implemented higher animal welfare measures. When looking at the ITW as a risk management tool, only the economic effects are objects of investigation. Possible effects regarding enhanced well-being and improved health status due to more individual mobility and offered activities are not taken into consideration.

2. Identification of the influencing factors afflicted with risk

As influencing factors afflicted with risk, the fattening pig prices, piglet prices and feed prices were chosen.

3. Procurement of time series for those factors

The historic data of the uncertain variables, fattening pig prices in €/kg carcass weight, piglet prices in €/28 kg and feed prices in €/268 kg has the same source as used for the extra-cost accounting of the animal welfare scenarios (AMI 2002a – 2020a; AMI 2002b – 2020b; BLE 2020b). The examined time periods encompass the months between 05/2015 to 12/2017 and from 01/2018 to 08/2020.

4. Calculation of the targeted figure with the historic price data of the influencing factors afflicted with risk at all past dates of the time period

The targeted figure is the contribution margin, already defined under sub-section 3.3. For the historic simulation the formula of the CM is extended by the extra-costs of implementing the FAW criteria for each scenario and the payed renumeration:

$$Contribution\ margin\ (Fattening\ pigs) = \left(x_{pig} * p_{pig}\right) - \left(x_{piglet} * p_{piglet}\right) - \left(x_{feed} * p_{feed}\right) - Extra\text{-}costs\ \left(\frac{€}{pig}\right) + Renumeration\ (\frac{€}{pig})$$

Formula 7: Contribution margin for historic and stochastic simulation

The extra-costs of the realized FAW measures were assumed to be constant as well as the payed renumeration. The loss of CM due to space requirements is already taken into account, calculating with the corresponding fattening pig places for each scenario. For each month the CM in €/pig was calculated out of the price data of the uncertain variables.

5. Creation of a risk profile of the targeted figure in form of a cumulative relative frequency distribution

The presentation of the risk profile of the CM for each scenario was made by means of percentiles and the related percentile values. The percentiles indicate the selection probability which with the CM exceeds or undercuts a certain value. The division of the percentiles depends on the amount of observations. To provide an overview, only the 5%-percentile, the 10%-percentile and the 25%-percentile are shown in the results. It should be noticed, that the generated statements of the percentile calculation have to be evaluated in combination with the individual risk attitude to analyze a risk profile all-embracing. The percentile values, based on the prices of the uncertain variables and the CM, were calculated with the EXCEL-function VLOOKUP[27] which organizes the data according to the outputted quantiles. Additionally, to the percentiles, the value-at-risk figure was calculated. The stochastic figure specifies the probability with which a certain shortfall originating from the expected value will not be exceeded (Hirschauer & Mußhoff 2012).

The normal distribution can be presented graphically with the NORM.DIST function in EXCEL which returns the normal distribution for the indicated mean and the standard deviation. With this function both, the cumulative distribution function as well as the probability density function, can be displayed (Hirschauer & Mußhoff 2016). In addition to the graphic solution, the normal distribution can be characterized with the expected value μ and the standard deviation σ as well. The expected value μ is the average value and according to Henze (2019) defined as followed:

$$\mu\,(X) = \mathbb{E}\,(X) = \sum_{j=1}^{s} X\left(\omega_j\right) * \mathbb{P}\left(\{\omega_j\}\right)$$

[27] Detailed information at: https://support.microsoft.com

Formula 8: Expected value

The term $\sum_{j=1}^{s} with\ P_j = 1$ characterize the sum of characteristic values whereby s stands for the amount of observations, $X_{(\omega_j)}$ for the possible characteristic value and $\mathbb{P}\ (\{\omega_j\})$ for the probability of occurrence.

The standard deviation σ is the root of the variance $\mathbb{V}\ (X)$ and represents the degree of scattering around the expected value (Henze 2019; Hirschauer & Mußhoff 2012):

$$\mathbb{V}\ (X) = \mathbb{E}\ [X - \mathbb{E}\ (X)]^2 = \sigma^2(X)$$

Formula 9: Calculation of variance

$$\sigma\ (X) = +\sqrt{\mathbb{V}(X)} = \sqrt{\sigma^2(X)}$$

Formula 10: Calculation of standard deviation

The standard deviation can be taken a measurand for risk and allows to capture the whole scattering of the targeted figure under normal distributed uncertain values.

6. Provision of steps 2 to 5 for all defined action alternatives

The above described steps, calculation of the percentiles, the percentile values, the expected value and the standard deviation, as well as the value-at-risk figure, were implemented for all FAW scenarios.

7. Comparison of the five risk profiles

The comparison is carried out using the graphic representation as well as the representation via the expected value, the standard deviation and the percentile values. An explicit recommendation for an FAW scenario with risk profiles is not always possible. Besides the costs and the extent of risk reduction, the individual risk attitude and therefore the individual benefit of a certain risk reduction is not part of the analysis. According to Hirschauer & Mußhoff (2012) this is called “model-exogenous decision-making”.

3.4.3 Stochastic simulation

The stochastic simulation, also called Monte-Carlo-simulation, is based on repeated random sampling of the uncertain variables and on estimated breakdowns (Raychaudhuri 2008). The procedure is similar to the historic simulation (see Hirschauer & Mußhoff 2012):

1. Determination of the action alternatives to be analyzed

For the stochastic simulation, only four FAW scenarios will be analyzed because there will be no direct specific time period to analyze. That is why the scenario “Without ITW before” and the “Control”-scenario will be merged to one, just called “Control”-scenario.

2. Identification of the influencing factors afflicted with risk

This step is the same as for the historic simulation.

3. Procurement of time series for those factors

The expected value and the standard deviation as a basis for the simulation refer to the time period from 07/2007 to 08/2020. There will be no distinction between the different scenarios for the time period.

4. Estimation of the parametric distribution for those factors and calculation of their correlations

The parameters of the disaggregated random variables are exemplary presented for the ITW1 scenario in Table 9.

5. Computer-aided generation of a random value for each cause variable in consideration of correlations

For every simulated uncertain variable, a standard normal random variable is generated with the EXCEL-function NORMSINV(RAND()).

6. Calculation of the targeted figure on the basis of the values which were simulated for the different influencing factors

The targeted figure is the same as for the historic simulation, formulated in Formula 7.

Table 9: Paramter for disaggregated random variables for stochastic simulation for ITW1 - scenario (own table)

	Fattening pigs	Piglets	Feed	Loss of CM	Extra-costs	Re-numeration
Portfolio weighting [kg]	95,7	- 28,8	- 267,6	- 1	- 1	1
Expected price [€][1)]	1,54	1,83	0,25	2,89	1,80	5,10
Standard deviation of price [€/pig][1)]	0,18	0,36	0,03	1,00	0,00	0,00

[1)] The means and the standard deviations of the prices are based on the time period of each price from 07/2007 to 08/2020, except for the constant extra-costs and payed renumeration.

7. Repetition of steps 5 and 6 for 10.000 simulation runs

The simulation runs are repeated at least 10.000 times to illustrate the distribution according to the law of large numbers preferably good.

8. Creation of a risk profile of the targeted figure in form of a cumulative relative frequency distribution

The creation of the risk profiles was made graphically, as already explained under 3.4.2, and by means of the stochastic key figures expected value and standard deviation.

9. Provision of steps 2 to 8 for all defined action alternatives

10. Comparison of the four risk profiles

Further, the concept of the stochastic dominance will be used. This concept considers the different states of the uncertain variables and probabilities with which the uncertain variables occur. An underlying assumption is, that the individual risk attitude of the decision-maker remains unkown. After creating the risk profiles, it will be proved if explicit recommendations for action can be made. For decision-makers who are risk-averse, a clear recommendation can be made when either an action alternative has the same risk but a higher expected income than the other action, or when an alternative has a lower risk and at least the same expected income level than the other one (Hirschauer & Mußhoff 2016).

3.4.4 Price scenario analysis

The profitability of the ITW depends, besides firm specific conditions like performance indicators, for instance daily gains, or implemented FAW measures and the amount of renumeration, on the market prices for fattening pigs, piglets and feed. The main cost positions within the fattening pig business form the costs for purchasing piglets and feed (LWK Schleswig-Holstein & SSB 2018; Rohlmann & Efken 2020). Against this background, the profitability of the ITW under different price scenarios depending on slaughter revenues, piglet costs and feed costs was examined. Therefore, two overall scenarios were compared to each other: one scenario with implementing the ITW1-scenario and one without.

The chosen variable to evaluate the effects is the direct-cost free performance (Dcfp) which was already defined in Formula 1 in section 3.2. In the case of the ITW1 price scenario analysis the Dcfp, here considering the possibility of opting[28], is specifically formulated as:

$$\begin{aligned} &Direct\text{–}\,cost\ free\ performance\ (ITW) \\ &\quad = \left(x_{pig} * p_{pig}\right) - \left(x_{piglet} * p_{piglet}\right) - \left(x_{feed} * p_{feed}\right) \\ &\quad - Opportunity\ costs - Direct\ costs - Extra\text{–}\,costs \\ &\quad + Renumeration \end{aligned}$$

Formula 11: Direct-cost free performance for scenario ITW1

The opportunity costs were calculated for the loss of revenues which occurs due to the lower amount of fattening pigs at the ITW1-scenario. Those costs were calculated for every price scenario at a number of 27.144 fattening places (without ITW: 30.160 fattening places). The direct costs include costs for the veterinarian and medicines, water and electricity supply, animal diseases fund, animal insurance, cleaning and disinfection, disposal of dead animals, incidental expenses for pigs, fees for the slaughterhouses, purchased services, other materials and interest rates. The extra-costs are the costs which accrue for

[28] Within the agricultural sector the options of flat-rate taxation or opting exist. When purchasing something, the regularly value added tax of 19% or 7% has to be paid. If a farmer purchases goods or services from another compounding farmer, he has to pay a flat-rate tax of 10,7%. On sales for his products, the farmer receives a value added tax of 10,7%. A reconciliation with the tax authority is not necessary because the value added tax when purchasing and the one when selling are balance out (Hirschauer & Mußhoff 2016).

implementing the required FAW measures for the ITW1-scenario (see Table 7). In Table 10 the data used for the price scenarios is presented.

Table 10: Assumptions for ITW1 profitability under different price scenarios (own table based on Farm manager 2020)

	ITW1	Without ITW1
Carcass weight (kg)	95,69	
Piglet weight (kg)	28,77	
Feed consumption (kg)	267,59	
Direct costs (€/pig)	10,10	
ITW1 extra costs (€/pig)	1,80	-
Fattening places	27.144	30.160

The renumeration for the examined FAW-scenario amounts for 5,10 €/pig.

The formula for the Dcfp for the scenario without implementing the ITW is defined as:

$$Direct\text{-}cost\ free\ performance\ (without\ ITW) = (x_{pig} * p_{pig}) - (x_{piglet} * p_{piglet}) - (x_{feed} * p_{feed}) - Direct\ costs$$

Formula 12: Direct-cost free performance for scenario without ITW

For the price scenarios, prices for fattening pigs in €/kg carcass weight from 1,20 €/kg to 2,00 €/kg in intervals of 0,10 €/kg were assumed. For the piglet prices in €/piglet prices from 30 €/piglet to 80 €/piglet in intervals of 10 €/piglet presumed, while for the feed costs in €/dt, three different prices were investigated: 20 €/dt, 25 €/dt and 30 €/dt. Those intervals are based on the observation of the price series of all prices from 07/2007 to 08/2020 covering approximately all possible scenarios.

The price scenario analysis has to be separated from the business segment accounting in that way, that the business segment accounting includes all incidental costs whereas the scenario analysis only focus´ on the main cost positions outlined above.

4 Impact of ITW on farm

4.1 Impact of animal welfare on profit

The impact of animal welfare on the profit of the analyzed farm is on the one hand examined through the additional cost-accounting under section 4.1.1 and on the other hand through analyzing the effects of participating in the ITW by means of the full-cost accounting under 4.1.2.

4.1.1 Additional cost-accounting and threshold calculation

The following Table 11 shows the extra-costs of the ITW1 (program phase 2018-2020) which arise when implementing the basic criteria additional manipulable material (wood) and 10% more space per animal and the facultative criteria permanent access to roughage which were realized by the analyzed farm.

Table 11: Additional annual costs per fattening pig for farmers participating in ITW1 2018-2020 – Example calculation with 10.400 animal places[1)] (own table based on ITW 2020a)

Cost position	Arising costs [€/pig]
Average loss of contribution margin due to 10% more space	3,02[2)]
Annual investment costs	
Roughage	1,04
Wood (manipulable material)	0,03
Costs of extra work	0,52
Annual audit- and managing costs	0,20
Sum of costs	4,82
ITW1-payment	5,10
Difference	0,28

[1)] The space per pig rises from 0,75 m^2 to 0,825 m^2 per fattening pig (50-110 kg). In general, 10.400 animal places, with ITW 9.360 animal places. Further assumptions: 2,90 rotations/year, 27.144 fattening places (ITW 2020a). The annual basic renumeration of 500 € per farm will be neglected due to the fact that this payment is independent from the profitability of each farm and not influenced by the choice of implemented criteria.

[2)] Mean of loss of contribution margin due to 10 % more space from 01/2018 to 08/2020. The underlying performance parameters are: 95,7 kg carcass weight, 28,8 kg piglet weight and 267,6 kg feed/pig/fattening period.

The main cost positions are the loss of contribution margin due to 10% more space caused by the lower amount of fattened pigs followed by the costs for roughage. The amount of fattened pigs decreased from 30.160 to 27.144 pigs. The average loss of CM for the 3.106 less fattened pigs accounts for 3,02 €/pig,

taking into account market prices for fattening pigs, piglets and feed for the time period between 01/2018 to 08/2020. The annual costs of 1,04 €/pig for the material roughage are based on an assumed daily consumption of 30 g per day per pig at a price of 0,90 €/kg (Achilles et al. 2016). For the criteria roughage about 555 h per year, and for the manipulable material about 256 h extra work per year emerge at an assumed wage of 17,50 €/h. In total, the analyzed farm has to expect 4,82 €/pig extra costs, including the opportunity costs of fewer fattening places and for implementing the in Table 8 outlined requirements for the ITW1 program phase. The ITW1 covers the extra costs with a renumeration of 5,10 €/pig, so that a plus of 0,28 €/pig results. The underlying assumptions and calculation values as well as singular investment costs, which in this case account for about 50.000 €, are presented in Table A 5. The costs for the provision of a minimum of 1,5 % daylight (see Table 6) are neglected, because this standard was already fulfilled by the examined farm. Incidental costs for entrepreneurial risk in form of stochastic key figures are considered within the risk analysis under section 4.2. The savings in piglet and feed costs as well as in veterinarian costs which occur due to a lower amount of fattened pigs, are examined under section 4.1.2. Other costs like the issue of more manure in the scenario without ITW, opportunity costs storing the roughage and additional manipulable material as well as depreciations and inflation are not considered.
Originating from the average loss of CM, the ITW1 renumeration of 5,10 €/pig is enough to cover the extra costs. At a loss of CM ≥ 3,30 €/pig the ITW1-payment of 5,10 €/pig does not cover the extra costs of implementing the ITW1-criteria “10% more space”, “additional organic manipulable material” and “roughage”. In total, 41 % of all losses of contribution margin from 01/2018 to 08/2020 were ≥ 3,30 €/pig. The specific period of time was chosen because the analyzed farm started implementing the requirements for the ITW1 in 01/2018.

In Table 12 it is shown that the extra costs of the ITW2 (2021-2023) are slightly lower with 4,63 €/pig than of the ITW1 before. This is due to the elimination of the compulsory criteria “manipulable material”.

Table 12: Additional annual costs per fattening pig for farmers participating in ITW2 2021-2023 – Example calculation with 10.400 animal places[1)] (own table based on ITW 2020a)

Cost position	Arising costs [€/pig]
Average loss of contribution margin due to 10% more space	3,02
Annual investment costs	
Roughage	1,04
Wood (manipulable material)	0,00
Costs of extra work	0,36
Annual audit- and managing costs	0,20
Sum of costs	4,63
ITW2-payment	5,28
Difference	0,65

[1)] The space requirements as well as the other assumptions, rotations/year, the neglection of the basic renumeration of 500 € per farm, the underlying assumptions for the mean of loss of CM as well as the performance parameters, will be the same as for Table 11 (ITW 2020a).

Besides the change for the manipulable material, the requirement of offering roughage is now mandatory. The costs for extra work are reduced due to the elimination of replacing the wood pieces annually. All other assumptions, as made for the ITW1-scenario before, remain the same. The higher ITW2-payment of 5,28 €/pig and the lower total extra costs per pig lead to a plus of 0,65 €/pig. The detailed underlying assumptions and total singular investment costs, which amount to about 31.000 €, are illustrated in Table A 6.

At a loss of CM ≥ 3,67 €/pig the ITW2-payment of 5,28 €/pig does not cover the extra costs of implementing the ITW2-criteria “10% more space” and “roughage”, whereby in total about 19 % of all losses of contribution margin from 01/2018 to 08/2020 were ≥ 3,67 €/pig.

The following Figure 9 shows the proportions of the different extra costs of the ITW adding the singular investment costs and comparing the ITW1-scenario with the ITW2 starting from 2021. It is obvious that the loss of CM constitutes the greatest annual cost component depending on the prevailing market price constellation. The singular investment costs represent a relatively high cost position for the farmer in the beginning.

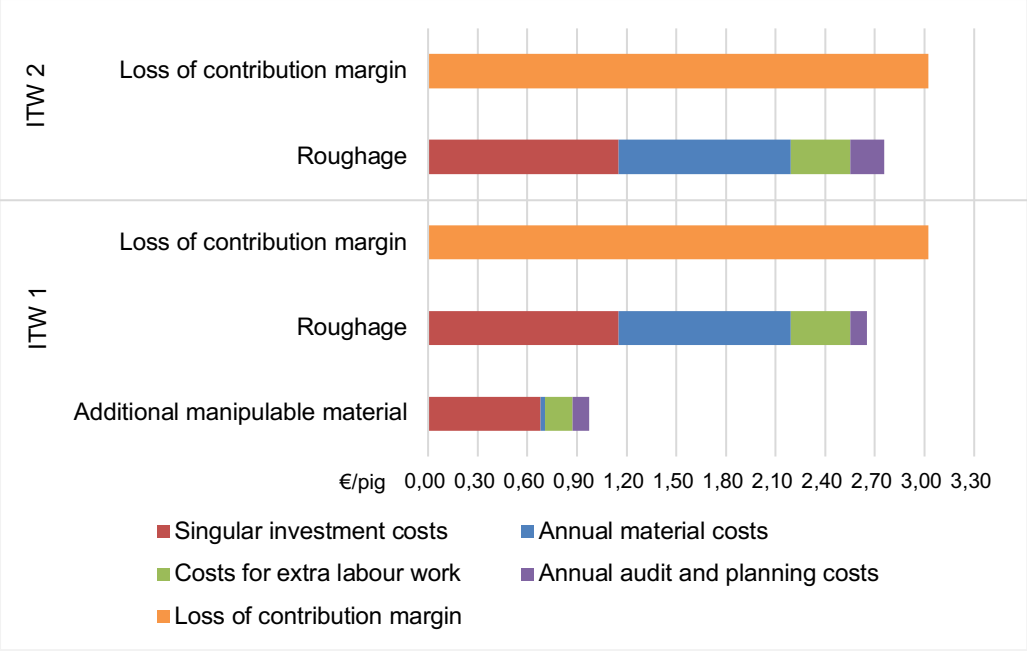


Figure 9: Extra-cost components for ITW-scenarios in €/pig (own figure)

In Table 13 the additional annual costs for implementing the requirements of level one of the planned German state label for animal welfare are represented (see Table 7). The other assumptions like the chosen time period for the loss of CM, remain the same as for the ITW scenarios. The sum of costs for the criteria of the state label are with about 12 €/pig considerably higher in comparison to the ITW-scenarios. The mean of the loss of CM, caused by 20% more space for the animals, is decisive for the high extra costs. The main cost positions besides the average loss of CM are the annual material costs for the pellet dispenser and the annual labor costs for maintaining the roughage and pellet dispensers and exchanging the wood pieces. If a renumeration of 6 €/pig is assumed, there would be still a loss of 5,65 €/pig for the farmer. It should be noticed, that these calculations only focus on the extra costs in proportion to the renumeration, cost savings in feed and piglets are not considered in this calculation but need to be kept in mind. Additionally, there are high singular investment costs of about one-time 531.000 €, for which the calculations are illustrated in Table A 7.

Table 13: Additional annual costs per fattening pig for farmers participating in the German state label – Example calculation with 10.400 animal places[1)] (own table based on BMEL 2020a)

Cost position	Arising costs [€/pig]
Average loss of contribution margin due to 20% more space	6,05
Annual investment costs	
Roughage	1,17
Wood (manipulable material)	0,03
Pellets	2,20
Costs of extra work for wood, roughage and pellet dispenser	2,00
Annual audit- and managing costs	0,20
Drinking from open surfaces	0,11
Rubber mats	0,11
Sum of costs	11,65
Animal welfare payment	6,00
Difference	- 5,65

[1)] The space per pig rises from 0,75 m^2 to 0,90 m^2 per fattening pig (50-110 kg), so that there are now 8.320 animal places. Further assumptions: 2,90 rotations/year, 24.128 fattening places. The chosen criteria depend on the published preliminary requirements of the state label by the BMEL (2020a). Other assumptions, as the ones for the mean of loss of CM as well as the performance parameters, will be the same as for Table 11.

4.1.2 Effects of ITW in full cost-accounting

The analysis of the business segment pig fattening with the purpose of a past-oriented post calculation leads to a comparison of the key figure direct cost-free performance between the different fiscal years as well as of the scenario with the ITW1 (2018-2020) and the scenario without participating in the ITW1 in 2018/19. The results are presented in Figure 10.

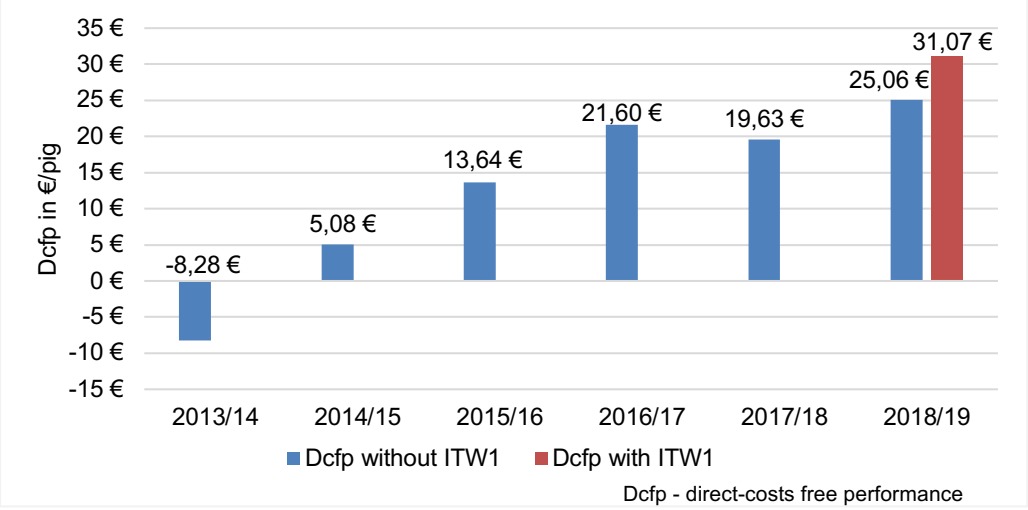


Figure 10: Direct cost-free performance of the analyzed farm from the fiscal years 2013/14 to 2018/19 with the effect of the ITW1 (own figure)

For the year 2018/19, a price of 1,37 €/kg carcass weight is the assumed (market price for December 2018 according to BLE 2020b).The price for liquid manure is assumed to be zero. First of all, there is an obvious increase in the Dcfp over the selected years, with the exception of 2017/18 where the Dcfp declines. The major reasons for the improved profitability are reduced animal losses and thus lower proportionate costs per pig, an increased average slaughter weight while maintaining an almost constant fattening period and slightly rising daily gains over the years, as well as decreasing interest rates for long-term liabilities and a reduction in costs for feed. The good economic position for farmers in 2016/17 is mainly caused by high market prices for fattening pigs between July 2016 and September 2017.

The analyzed farm gains a plus of 6,01 €/pig in Dcfp in 2018/19 due to participating in the ITW1. The ITW1-payment compensated the extra costs and the loss of revenues caused by a lower amount of sold fattened pigs. Fix costs,

which are independent from the scope of fattened pigs and therefore from the participation in the ITW like building costs and partly employment-related costs, are split to lower amounts of animals which leads to higher fix costs per pig. This is illustrated in Figure 11 where the different cost categories, according to the DLG cost scheme (see Table A 4), of the scenario with ITW1 are compared with the scenario without ITW1 for the fiscal year 2018/19.

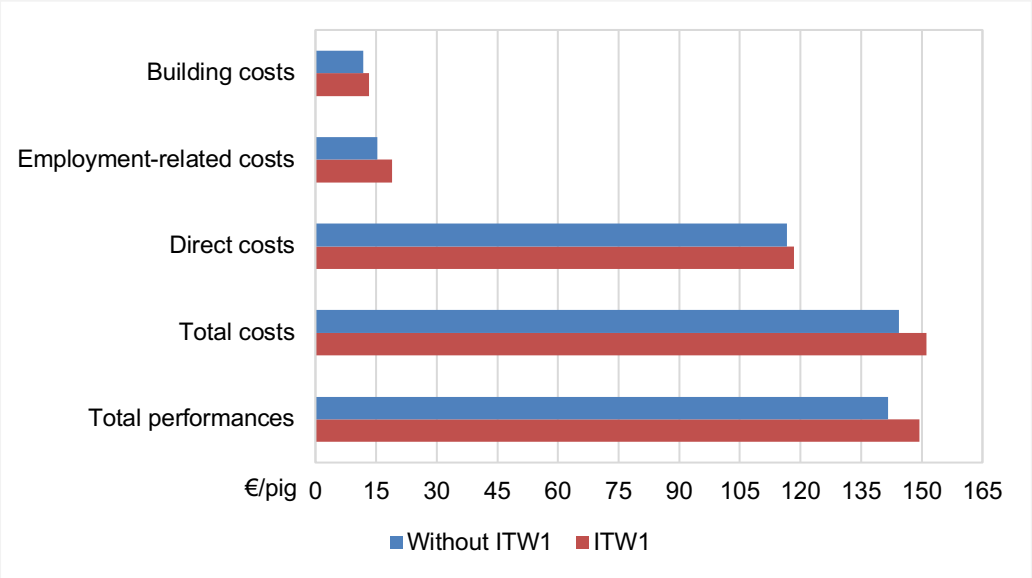


Figure 11: Comparison of total costs and total performances in 2018/19 with ITW1 and without ITW1 (own figure)

The total costs per pig are from 144,29 €/pig without the ITW1 to 151,20 €/pig with ITW1 about 4,80 % higher for the analyzed farm when participating in the ITW1 program. The extra costs for implementing the ITW1 requirements are considered within the employment-related costs that is why there is the largest difference compared to the costs without ITW1. The direct costs are with 1,60 % slightly higher under the ITW1, mainly due to the fact that the interest rates are split to lower amounts of animals. The singular investment costs are not part of this calculation.

4.2 Impact of animal welfare on risk profile of farm

4.2.1 Historic simulation

The stochastic analysis of the five FAW-scenarios, described in Table 8, by means of the historic simulation was made both tabularly and graphically.
From Table 14, it can be seen that ITW2 provides the highest expected CM out of the analyzed scenarios. Even though the planned state label for FAW has the lowest standard deviation with 8,49 €/pig, the expected outcome in form of the CM indicates the high costs of implementation fulfilling the requirements for livestock farmers. Participating in the ITW will lead to reduced CM fluctuations compared to the control scenario as well. In comparison to the control scenario without taking part in the ITW between 01/2018 to 08/2020, the standard deviation of the analyzed farm is reduced by about 11 %, also called hedging effectiveness. The hedging effectiveness describes the ability to reduce the scattering of the relevant key figure. The highest hedging effectiveness has the state label scenario with about 30 % compared to the control scenario. Further, in combination with a slightly higher expected CM of around 0,27 €/pig and 0,65 €/pig more, the ITW scenarios are the less risky choices regarding those stochastic figures and the underlying assumptions.

Table 14: Results of historic simulation – simulated contribution margin (own table)

Scenario	Expected contribution margin (CM) **[€/pig]**	Standard deviation **[€/pig]**	Hedging effectiveness on the basis of "control"-scenario **[%]**	Middle 50%-interval of CM **[€/pig]**
Without ITW before	28,74	10,85	2,16	- 4,22 – 28,53
Control	30,24	10,62	-	8,05 – 29,91
ITW1	30,51	9,55	- 11,20	10,54 – 30,22
ITW2	30,89			10,92 – 30,60
State label	23,38	8,49	- 25,09	6,63 – 24,12

The already above stated stochastic figures expected value and standard deviation of the historic simulation are graphically illustrated in Figure 12.

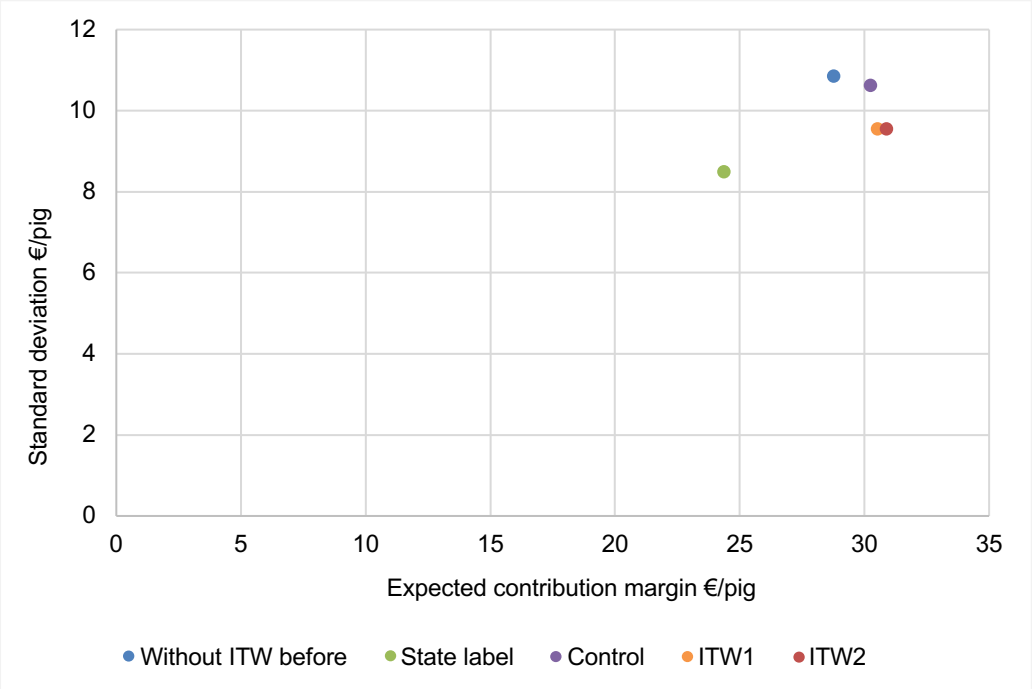


Figure 12: Expected contribution margin and standard deviation in €/pig of the historic simulation for the FAW-scenarios (own figure)

The reason that the ITW2-scenario results in a slightly higher expected CM per pig is mainly due to the higher renumeration and also due to the discontinuance of the organic manipulable material. Moreover, it gets obvious that the general economic situation before, between 05/2015 and 12/2017, characterized by the scenario “without ITW before”, was not as good as the following period.

In Table 15 the stochastic figure value-at risk shows that at the ITW-scenarios with a probability of 90 % a loss of 12,24 €/pig originating from the particular expected CM will not be exceeded. Compared to the control scenario, the loss accounts for 13,62 €/pig and when looking at the scenario “without ITW before”, the difference is at a value of 13,90 €/pig even greater. This supports the conjecture that the ITW-scenarios are the less risky choices.

Table 15: Results of historic simulation – Value-at-Risk in €/pig (own table)

	Percentiles	Percentile values of standard-normal distribution	Percentile values of CM - distribution **[€/pig]**	Value-at-Risk **[€/pig]**
Without ITW before	5% - Percentiles	-1,64	10,89	17,84
	10% - Percentiles	-1,28	14,33	13,90
	15% - Percentiles	-0,67	21,42	7,32
Control	5% - Percentiles	-1,64	12,77	17,46
	10% - Percentiles	-1,28	16,63	13,61
	15% - Percentiles	-0,67	23,08	7,16
ITW1	5% - Percentiles	-1,64	13,91	15,72
	10% - Percentiles	-1,28	17,38	12,24
	15% - Percentiles	-0,67	23,18	6,44
ITW2	5% - Percentiles	-1,64	14,18	15,72
	10% - Percentiles	-1,28	17,63	12,24
	15% - Percentiles	-0,67	23,38	6,44
State label	5% - Percentiles	-1,64	9,41	13,97
	10% - Percentiles	-1,28	12,49	10,88
	15% - Percentiles	-0,67	17,65	5,73

In Figure 13 the risk of the relevant key figure, in this case the CM, is presented in form of the distribution function. On the basis of the illustrated risk profiles of the various FAW scenarios, explicit recommended actions can be made by means of the concept of stochastic dominance. The stochastic dominance applied to normal distributed random variables is easy to understand. The FAW scenarios ITW1 and ITW2 have second degree stochastic dominance towards the “control” scenario. To conclude a final recommendation, the underlying assumption is that the farmer has to be risk averse. Until the intersection at a percentile value of 31,66 €/pig for the scenario ITW1 and 36,74 €/pig for the current ITW2, the ITW-scenarios dominate the scenario without participating in the ITW (control). This means, that the risk to fall under these values is with the ITW lower than without. For all the other values above, the probability of a shortfall is lower for the control scenario. As long as the area under the intersection is larger than above that point, the decision of implementing the ITW on farm level dominates, considering risk aversion. The compression of the cumulative density function shows the reduction of the scattering of the CM graphically.

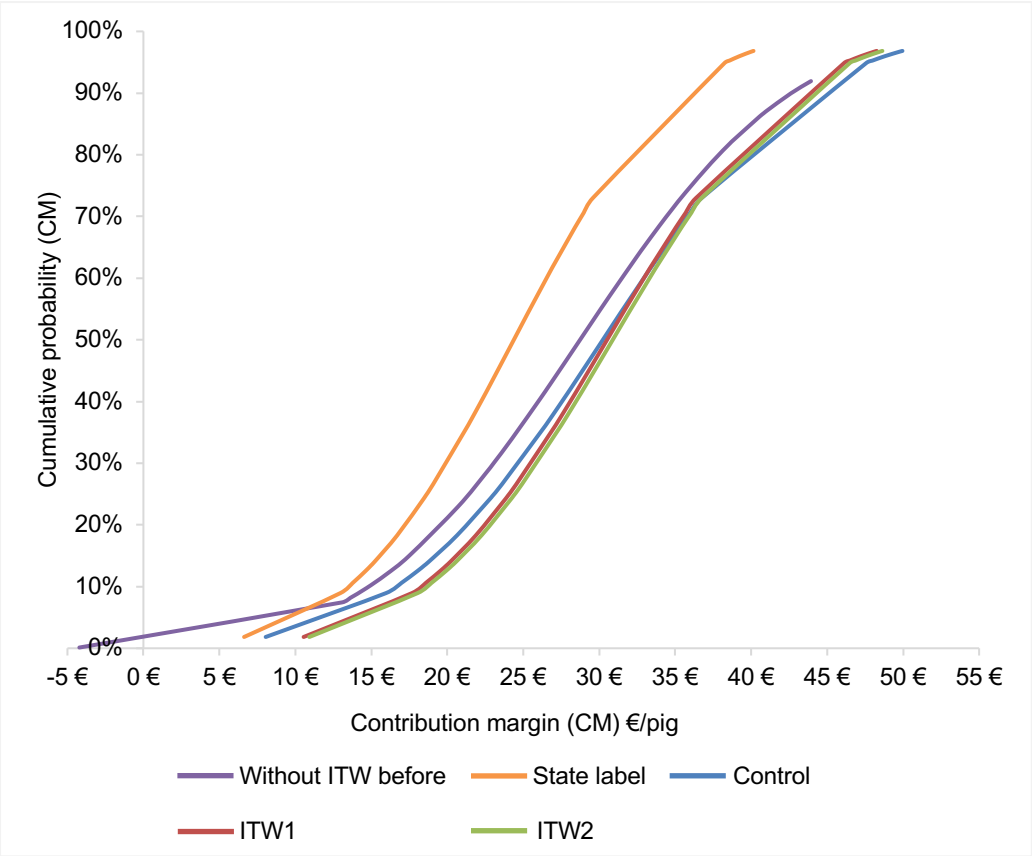


Figure 13: Risk profile of FAW scenarios from historic simluation (own figure)

Looking at the state label in comparison with the ITW1-scenario, a participation in the planned state label will lead to a by 7,13 €/pig lower CM, whereas the fluctuation of the CM can be reduced by circa 30,50 % due to the assumed high renumeration to cover the relatively high extra costs and high losses of CM caused by 20 % more space. This tradeoff between the lower expected CM and the reduced scattering of the CM of those two scenarios does not allow a clear recommendation for action as it is, according to Hirschauer & Mußhoff (2016), a so called “practical relevant” situation. For an explicit action recommendation, the degree of the farmer´s risk aversion has to be known. A similar situation applies for the comparison of the alternatives state label and control scenario. Because the normal distribution is defined from minus infinite to plus infinite, it is difficult to present the point of intersection near the area of minus infinite graphically.

4.2.2 Stochastic simulation

In Table 16 the results of the stochastic simulation for the four FAW scenarios are presented.

Table 16: Results of stochastic simulation – simulated contribution margin (own table)

	Control	ITW1	ITW2	State label
Expected contribution margin **(€/pig)**	29,06	29,29	29,71	23,05
Standard deviation **(€/pig)**	21,32	21,77	21,42	21,63
Minimum **(€/pig)**	- 48,75	- 53,81	- 51,58	- 66,66
Maximum **(€/pig)**	128,14	109,85	113,80	105,33
Potential negative CM **(%)**	8,89	7,11	7,39	8,86
Middle 50%-interval of CM **(€)**	- 48,75 to 29,14	- 53,81 to 29,14	- 51,58 to 29,80	- 66,66 to 23,17

The procedure of the stochastic simulation, more specifically the generation of 10,000 random values, leads to an improvement of the precision of the expected CM in contrast to the historic simulation where only the exact time period with the prevailing market prices was examined. However, the stochastic simulation leads to the same order of priority regarding the expected CM as the historic simulation. The maximum expected CM of 29,71 €/pig can be reached with the ITW2-scenario. The ITW delivers with circa 7 % the lowest potential of gaining a negative CM. The values for the standard deviation are resemble one another for the various scenarios because of the law of large numbers and the generation of many random numbers in the course of random drawing.

In Figure 14 the risk profiles of the different FAW scenarios from the stochastic simulation are shown. The curves for the two ITW-scenarios are almost identically which is why their curves are overlapping. Referring to the concept of the stochastic dominance, an explicit recommendation for action, comparing the ITW-scenarios and the control scenario with each other, cannot be made.

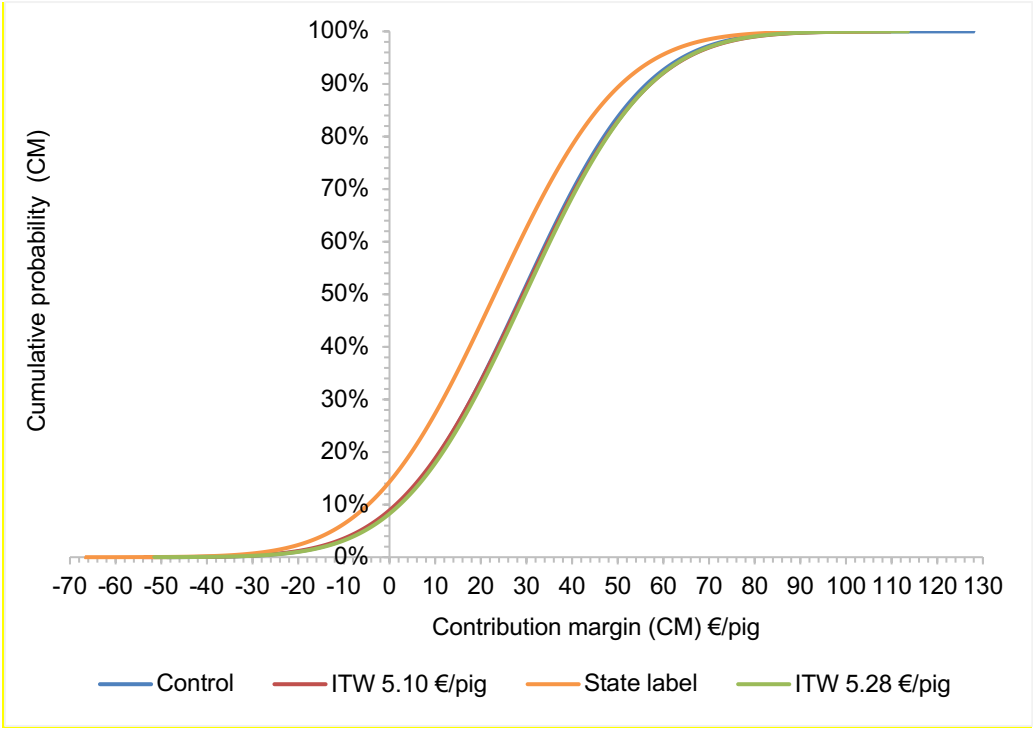


Figure 14: Risk profile of FAW scenarios from stochastic simluation (own figure)

4.2.3 Price scenarios

The profitability of the participation in the ITW depends, besides other influencing factor like performance parameters, on current market prices. The calculations in Table 17 show, that at a market price for fattening pigs of 1,60 €/ kg carcass weight almost no combination of piglet prices and feed prices will lead to a situation where participating in the ITW1 is more profitable regarding the Dcfp and the underlying assumptions than not participating. The figures marked orange represent the negative difference of the Dcfp taking part in the ITW1 and not taking part. Focusing on the probability of occurrence of certain pig prices, the majority, in total circa 75 % of the pig prices from 2001 until 2020, were lower than 1,60 €/kg.

Table 17: ITW1 profitability under different price scenarios - depending on slaughter revenues, piglet costs and feed costs (own table)

Fattening pig prices €/kg	Piglet prices €/28kg	Feed prices €/dt		
		20 dt	25 dt	30 dt
		Loss of Dcfp €/pig		
1,30	30	- 0,79	0,55	1,89
	40	0,20	1,54	2,88
	50	1,21	2,55	3,89
1,40	30	- 1,74	- 0,41	0,93
	40	- 0,73	0,58	1,92
	50	0,26	1,59	2,93
1,50	30	- 1,70	- 1,36	- 0,03
	40	- 1,69	- 0,35	0,96
	50	- 0,70	0,64	1,97
1,60	30	- 3,66	- 2,32	- 0,98
	40	- 2,65	- 1,31	0,02
	50	- 1,66	- 0,32	1,02

In Table A 8 in the appendix, the table is extended by more price scenarios. From a pig price over 1,80 €/kg, at all in Table 17 chosen feed and piglet prices, not taking part in the ITW1 is more profitable than implementing the required FAW standards at a renumeration of 5,10 €/pig. At a market price for fattening pigs of 1,40 €/kg and 1,50 €/kg it depends on the currently existing prices for piglets and feed if the ITW1 leads to a higher Dcfp than without. Between 2001 and 2020, in total circa 25 % of the pig prices were between 1,40 €/kg and 1,50 €/kg and around 34 % under a pig price of 1,40 €/kg. The likelihood of

occurrence to achieve a pig price over 1,70 €/pig within the last 20 years amounted to circa 13%. With the ITW2, the profitability is slightly different in that way, that the limit at which the Dcfp of not taking part in the FAW program is shifted towards higher pig prices, so that the ITW2 is “longer” profitable than the ITW1 compared to the control scenario.

Looking at the monthly development of the market prices for fattening pigs and piglets from 2001 to 2020, as presented in Appendix 2, it gets obvious that these are subjects to relatively large fluctuations. The graphic clarifies the fluctuations of both prices whereas it can be assumed that the prices for piglets are more volatile than those for fattening pigs. From 2006 to 2007, in 2008, in 2014, in 2017 and in 2020 huge decreases in prices for fattening pigs can be observed. In the second half of 2019 the prices increased immensely due to the increased demand of pork from mainly China and other Asian countries which were affected with the ASF. Constant changes in supply and demand, both on national as well as on international level, contribute to this development as well.

There is a significant correlation between the piglet prices and the prices for fattening pigs. The correlation coefficient, as stated in Table 18, has a value of 0,73 and is relatively high, indicating a strong correlation. Furthermore, the prices for pigs and feed are also correlated with each other but with a correlation coefficient of 0,39 not as strong as the price series of pigs and piglets. There is almost no correlation between the feed prices and piglet prices.
The correlation between the prices for pigs and the piglet prices is often described as a natural hedge. The natural hedge builds upon the positive correlation between the performance value, pig prices, and the cost value, prices for piglets. High piglet costs in general tend to coincidence with high revenues for fattening pigs and the other way around as well. This leads to a stabilization of the contribution margin, and therefore to a risk reduction without applying an extra risk management strategy. A reduction of the scattering of a single cause variable, e.g. the artificial stabilization of the piglet prices, would lead to an increased risk. The described state of affairs can be seen in Appendix 2, particularly for instance in 2017 and in the first half of 2020.

Table 18: Stochastic analysis of prices for fattening pigs, piglets and pig feed (own table)

	Price per carcass weight [€/kg]	Piglet price [€/piglet]	Feed price [€/dt]
Survey period	01/2001 – 08/2020		08/2007 – 08/2020
Mean	50,00	1,49	24,74
Best case	31,00	2,00	17,70
Worst case	85,00	1,05	34,30
Pearson	Fattening pig prices	Piglet prices	Feed prices
Fattening pig prices	1,00	0,73	0,39
Piglet prices		1,00	0,08
Feed prices			1,00

5 Discussion

In the following, with a view to the superordinate research questions, the analysis of the profitability of the ITW will be finally discussed.

First of all, the ITW will be classified into the various definitions of FAW, presented under 2.1.1, to analyze to which extent the requirements of the ITW correspond to FAW. The definitions of the OIE (2019a), Fraser (2009) and Keeling & Kjærnes (2009) highlight the importance of a stimulating environment, that enable animals to act in their natural way and to express appropriate behaviors that are important for their physical and mental state. Referred to pigs, behaving in natural ways means exploring, rooting, gnawing, scratching, rubbing and foraging including restrictive feeding (Opderbeck et al. 2020 see Becker 2020; Köhler 2005; Zwicker et al. 2013). The offering of functional areas plays an important role. The most widespread floor systems are slatted floors which have their entitlements in particular due to hygienic reasons. To ensure sufficient functional areas, adequate lying surfaces and possibilities for thermoregulation, e.g. showers have to be offered (Opderbeck et al. 2020 see Becker 2020). Additionally, during the time of feed intake, pigs have a marked need for exploring as they normally spend 70 % of their active time to searching for feed to achieve saturation. This includes swigging from open surfaces (Bauer et al. 2019). The movement behavior is improved by the ITW due to 10 % more space, while the mandatory offering of roughage in ITW2, in combination with the legally required manipulable material, satisfy the need for gnawing, partly playing and exploring. Looking at the outlined complex characteristics and needs for natural behavior, those requirements are not sufficient to fulfill all needs of pigs. Raising the ITW criteria to higher FAW standards, e.g. including mandatory devices for rubbing or digging, is recommendable because likely prospectively higher FAW standards will be the norm anyway (Heise 2016). Whereas, the standards of the planned German state label, level 2 of the Borchert-Commission (2020) and the guidelines of the WBA (2015) enable most of the natural behavior properties of pigs. Looking at other aspects of FAW definitions, ensuring physical health, freedom from hunger and thirst, a safe environment, disease prevention and appropriate veterinary care (European Commission 1976; OIE 2019a; Welfare Quality 2009), cannot be evaluated out of a catalogue of criteria and mainly depend on the farmer´s individual management. Developing a common

definition of FAW within the ITW as well as communicating the offered FAW ITW-criteria embedded in a common definition to society seems indispensable for a sustainable basis of trust on consumers side and a long-term effective implementation of the ITW on the market. It will as well contribute to a more objective based discussion about FAW in Germany which is currently dominated by emotional discourses (Kühl et al. 2018). In long-term, this might help to reduce the loss of social acceptance and skepticism against FAW labels. On farmers´ side, a common definition can contribute to a better understanding of what the complex term encompasses, what can be directly done by the farmer to enhance the welfare of kept animals and a clearer communication between farmers and consumers would be possible. Within the general criticism of society against the agricultural sector, strengthen the farmer-consumer relation is important to reduce the consumer-citizen gap, and enhance also regional products.

Because the requirements of the ITW, compared to the planned German state label or the label “Für mehr Tierschutz” of the German Animal Welfare Association, are relatively low, the incidental extra costs for the farmer are comparably low which can be covered as the results of this thesis show. This might lead to a higher willingness of the farmer to participate as it seems less risky than taking part in an FAW label with more costly requirements to realize in the first place. According to Spiller et al. (2010), low entry levels of a label have an important function on the market because they provide an attractive option for producers as well as for consumers to take part in the FAW segment. Disadvantages of the easier market penetration in comparison to FAW programs with higher FAW standards are the marginal improvements of animal welfare. The requirements of the ITW2 enhance the mobility of the singular animal and allows the pigs to occupy themselves, but those measures present a minimum standard of what can be improved in regard to FAW. As a result of the qualitative interview, the Farm manager (2020) of the analyzed farm himself evaluated the implementation of the ITW1 requirements as “feasible”, whereby he valued the measure of 10 % more space as “no particular outstanding change with respect towards animal welfare”. The WBA (2015: 46) suggested for instance “access of all livestock to various climate zones (preferably an outdoor climate […]) and the

provision of different functional areas with various floor coverings". The "Bundesanstalt für Landwirtschaft und Ernährung" (BLE) published various concepts for stable constructions, considering the conflict between economic feasibility, FAW and resource protection, with a standard space of 1,30 m^2 per pig and partly straw based lying areas (Bauer et al. 2019).

In regard to the second research question, the effects of the fix ITW-price for implemented higher animal welfare standards on the profit of the pig fattening farming business, the participation in the ITW1 from 2018 to 2020 led to a positive performance-cost-ratio for the analyzed farm in the fiscal year 2018/19. The parameter direct-cost free performance (Dcfp) was chosen as a measure for the profitability of the ITW because all relevant direct costs are considered, and the resulting value is direct derivable out of the business segment accounting. Another appropriate and intuitively understandable parameter would have been the contribution margin which considers all relevant performance and variable cost positions depending on operational decisions as well as the incidental costs of the ITW (Spiller 2019a). In this thesis, the Dcfp was chosen to analyze the profitability of the farm, because the extra costs of the ITW were calculated separately. Besides focusing on the costs caused by implementing welfare criteria, Morgan et al. (2019) analyzed that animal welfare friendly management can lead to a reduction of costs caused by an improve in health of animals and in turn to the farmer, e.g. reduced stress levels and lowered potential for injuries. These savings were not part of the underlying analysis.

In comparison to results of average farms with fattening pigs listed in the report of the Chamber of Agriculture Schleswig-Holstein, farmers who participated in the ITW1 in 2017/18 generated a plus of 1.00 €/pig and in 2018/19 a plus of 1,30 €/pig in the Dcfp compared to farmers not taking part (LWK Schleswig-Holstein & SSB 2018). The analyzed farm in this thesis gained a relatively high plus in Dcfp with 6,01 €/pig with the ITW1 compared to the farms listed in the report of the Chamber of Agriculture Schleswig-Holstein. The reasons for this are in general farm specific parameters: high pig´s performance parameters and decreased costs like lower interest rates for long-term liabilities, as well as a relatively low piglet price of 50 €/piglet in 2018/19. The results of cost

calculations of various ITW-scenarios by means of a fattening pig farm with for one 960 and then again 1.920 animal places made by Schukat & Heise (2019a, 2019b), concluded similar increases using the individual cost-free performance[29] as a measure for profitability. Schukat & Heise (2019a, 2019b) conducted the calculations regarding the different possible requirements of the ITW1 (see Table A 2) investigating three different levels of performance: a low level with 2,77, a middle level with 2,85 and a high level with 2,92 rotations per year. For the highest performance level, which is comparable with the here analyzed farm, fulfilling the mandatory requirements plus permanent access to roughage as implemented by the example farm led to a negative individual cost-free performance whereas realizing all other ITW1 requirements like rubbing opportunities, drinking from open surfaces, air cooling devices and 20 % more space, led to a considerably positive performance-cost-ratio especially for the scenario with 2,92 rotations per year. The reasons for this are high material costs for straw of 10,50 € per pig. In the underlying farm case, the roughage is offered in form of a pellet with costs of 0,90 €/kg pellet, assuming a daily consumption suggested by the KTBL of 30 g/day/pig (Achilles et al. 2016). The catalogue of criteria made by the ITW allows a certain degree of freedom for the farmer to realize the criteria. That is why the underlying assumptions are presenting only an excerpt of the ITW and are farm specific. The criteria “permanent access to roughage” is the most important one, because now, for the ITW2 starting 2021, it is mandatory for all participating pig farmers. There are no quantity specifications but as an orientation value, depending on the used animal feed, the ITW proposes a daily consumption of 50 g/day/pig (ITW 2020c). The fulfilment of this reference will lead to an increase in annual investment costs for more material of circa 67 % and an increase of 54 % in annual labor costs due to the more frequently change of the pellet in the dispenser. The total extra costs for the ITW1 will raise from 1,80 €/pig to 2,69 €/pig and for the current ITW2 from 1,61 €/pig to 2,49 €/pig. Those changes would have significant effects on the profitability of the ITW.

[29] The individual cost-free performance considers the variable costs and the remaining fix costs like fix building costs, which can be directly assigned to one business segment and therefore includes in comparison to the Dcfp the extra costs of implementing the ITW (KTBL 2017).

Besides the scenario “mandatory requirements plus permanent access to roughage”, Schukat & Heise (2019a; 2019b) found out that implementing the other ITW1 criteria led in all cases of performance levels to an increase in profitability, in the best case up to 8,62 €/pig (low level of performance and implementing mandatory criteria plus 20 % more space). The performance parameter rotations/year has major influence on the profitability of an FAW program because the amount of loss of revenues due to space requirements are determining the opportunity costs for the farmer. These costs depend largely on market prices.

Another study published by the DLG (Ester-Heuing & Heil 2016), examined a conventional pig stable with 960 animal places and the following FAW measures: 1,10 m^2/pig, a device for digging, rubber mats, a waiver of tail docking and using an anesthesia for drugging the male piglets. This combination of FAW measures did not led to a positive result in capital value. Especially the way of castrating piglets has major influence on the profitability, for instance Morgan et al. (2019) indicate that replacing surgical castration with immunocastration contributes to a reduced stress level and higher weight gains. An increase of prices up to 10 % to 12 % would have been necessary, according to Ester-Heuing & Heil (2016), to cover the extra costs and to gain a positive capital value. With the exclusion of the requirement “additional manipulable material” and the increase in the payed renumeration from 5,10 €/pig to 5,28 €/pig in the new ITW2, the analyzed farm will prospectively gain a plus in Dcfp as well. If farms as the analyzed one and others, that already participated in the previous ITW1, will remove the installed additional manipulable material is doubtful. On the other hand, a continuation of the maintenance of the manipulable material like renewing and replacing, might probably not be the joint standard.

Nevertheless, besides the different requirements for the stable construction, farmers are now obligated to complete training measures, like specialist lectures about husbandry management (ITW 2020a). This requirement corresponds to one of the guidelines of the WBA (2015) (see Table A 1). Knowledge transfer, training and advisory are often seen as practices to raise awareness of farmers, disseminate best practices for an enhanced FAW management and promoting the competitiveness of animal husbandry. The farmers management has great

influence on the welfare of farm animals (Keeling & Kjærnes 2009). Well educated farmers and employees might establish new economic situations to act profitable and compliant with FAW standards. The support of implementing better advisory and education services, is also part of the agenda of the EU, as stated in the special report of the European Court of Auditors (ECA 2018). The European Commission (2020: 17) stated in last years published Farm to Fork Strategy that "Primary producers have a particular need for objective, tailored advisory services on sustainable management choices" and that effective agricultural knowledge and innovations systems needs to be provided for all actors of the food chain. Such participatory approaches are an integral part of agroecology[30] enhancing the use of human capital and empower the community of farmers (Altieri & Nicholls 2005).

Pretty and Hine´s (2000) emphasize the importance of good relations between farmers and external agencies and the mutual knowledge transfer. Nowadays, this becomes more and more important, for instance when looking at the nearly decided new "TA Luft", which caused severe criticism on the side of farmers, the farmer´s association and several other rural associations who for instance do not see the commensurability of stricter restrictions for exhaust air systems. Appropriate technologies adapted by farmers need to be affordable as well as compatible with conservation objectives and maintenance of competitiveness. One approach to solve such conflicts and achieve long-term solutions is interactive communication using instruments such as "round tables" which target at a cooperation of all stakeholders involved (Blackmore 2010). Strategic stakeholder management, which includes an active explicit management of external stake- and shareholders, and stakeholder analysis, aiming at identifying key stakeholders and assessing their respective interests, are necessary conditions to assist decision-makers in taking account potentially conflicting objectives of efficiency, equity and sustainability (Grimble 1998). An example for such a conflict is the, already in the introduction described, current discussion about higher FAW standards in Germany while simultaneously maintaining fair

[30] Agroecology is an encompassing systematic approach, embracing social, environmental and economic dimensions. The research field of agroecology includes farm and food systems, investigating the interactions and synergies between plants, animals, humans and the region-specific environment within agricultural systems (Carlsson 2020; Gliessman 2015; Wezel et al. 2009).

competitiveness, considering environmental goals and preserving natural habitats, promoting rural areas as well as funding sustainable feasible solutions for stable constructions. The interbranch agreement of the ITW tried to form a level playing field that realized such framework conditions for a generally accepted label. Schulze et al. (2019: 41) found, that especially food retailers have the potential to influence changes in production and consumption patterns because “their strategic role between farmers and consumers allows them to control commodity, information and value flow and therefore places them into a key position” distributing meat with higher FAW standards. Farmers and agricultural interest groups predict an image improvement of the livestock farming business and evaluate the ITW as an alternative for further legal tightening on a broad implementation level. The policy sees the ITW as a promotion of the discussion about animal welfare and animal protection, whereas the slaughtering industry highlights the advantage of financing additional costs of the whole animal not only of the high-quality fines.

On the other side, the food retailing evaluates the partly full-on participation of food retailing businesses in the ITW as problematic. There remains a risk for food retailers when not all retailers participate, and those offer meat at lower costs. Animal and environmental protection associations assess the ITW with the free-rider problem on the part of agriculture and evaluate the criteria as too low to achieve improvements in FAW (Betz 2019; Heise 2016; WBA 2015). Sundrum (2018) does not see advantages from the ITW on plant level because conventional primary producers are dominated by manufacturing industries due to a persistent oversupply of meat and therefore now in a situation with no assertiveness, not even with financial support from FAW programs. Further, farmers and agricultural interest groups criticize the missing acquisition of investment costs due to low financial resources even if they value the ITW as an important step to ensure the societal acceptance of the livestock farming sector. Another point of criticism is the restricted eligibility of criteria in the current ITW2, because especially the free eligibility of criteria enabled farmers to participate. Pig stables are equipped with different techniques and therefore a certain flexibility is necessary (Heise 2016). Nevertheless, a survey showed, that farmers still see potential for improvement, like clearer labeling in supermarkets, admission of all farms which fulfill the expected requirements, and they have

concerns about the uncertainty of the individual economic effects and international competitiveness (Heise 2016; Wellner et al. 2019; Winkel et al. 2019). Still, the market share of meat coming from businesses participating in an FAW program, which exceeds the legal requirements, remains small (Schulze et al. 2019).

Based on these economic concerns, as the results of the full-cost accounting under 4.1.2 show, the fix costs play a significant role. The fix costs are split to lower amounts of pigs due to the space requirements of the ITW which leads to higher fix costs per pig. Especially for farms with high fix costs, for instance farms with many buildings and operating facilities to maintain, outstanding high depreciations or farms with more than one operation manager, the costs per pig can increase strongly. The decision to participate in an FAW program has to be made in regard to the operation´s individual cost structure and material equipment. Furthermore, the results of the extra cost accounting under 4.1.1 have indicated, that the largest cost component of participating in an FAW program form the opportunity costs of selling a reduced number of fattening pigs. This raises the question if the herd size, and in the second place the performance parameters of animals, matter for the profitability of FAW programs. The answer to this question depends on the amount of the farm´s fix costs, the choice of FAW criteria to implement, the decision and implementability of augmenting missing animal places due to space requirements, the renumeration conditions of the funding program and the prevailing market prices which might lead to higher or lower opportunity costs. A commissioned study of the State Office for Agriculture and Rural Development Thuringia (Müller & Gräfe 2019) examined two scenarios comparing the implementation of FAW measures[31] on the one hand with reduction of the animal density of pigs without augmenting the missing animal places and on the other hand without reducing the amount of kept pigs but augmenting the missing animal places. Such operational decisions taken by farmers largely depend on building approvals and

[31] The implemented FAW measures for fattening pigs of the FAW-strategy of Thuringia contain: 29 % more space, permanent access to roughage, no tail docking and using alternatives for castration without drugging (Müller & Gräfe 2019).

on emission directives which are under constantly change and will get stricter due to rising environmental standards.
As seen in the results of the extra-cost accounting for the planned German state label, the average opportunity costs for increasing the space up to 20 % per pig in the period of July 2007 to August 2020 are with 6,05 €/pig relatively high. This does not mean that the FAW program is not profitable in the first place. The opportunity costs as well as the extra costs of implementing the FAW standards always have to be assessed in relation to the cost savings for feed and piglets and in veterinarian costs which decrease caused by lower amounts of kept pigs. That is why parameters as the CM, or the individual cost-free performance are valuable to assess the gross gain of a business decision.

As outlined in section 2.2.4, the German livestock sector has to deal steadily with different kinds of risks. The institutional and technological risk of stricter provisions in the field of emission control, manure spreading and FAW combined with increasing social requirements on FAW and environmental protection, leads to the editing of the third research question about the extent of the ITW as a risk management instrument for the analyzed farm. The question was analyzed using the numeric quantitative measures historic and stochastic simulation for establishing a risk profile. The historic simulation is relatively easy to carry out and is based on the empirical monitored prices for fattening pigs, piglets and feed in the time period between 01/2018 and 08/2020. The past-oriented simulation allows a time specific analysis of the decision participating in the ITW that is why it is also called “what-if-analysis” (Hirschauer & Mußhoff 2012). On the other hand, the results of the historic simulation only allow an analysis of a specific time section, so that the results cannot be indicators for meaningful predictions. On the contrary, the stochastic simulation, due to the frequently repeated simulation runs, leads to a more precisely distribution of the target figure. In general, it is possible to integrate arbitrary parametric distributions for the random variables, e.g. triangular distributions when time series data is missing, and experts have to be consulted for price information. Further, it should be noted, that risk management is always company-specific and operator-specific, so that there are no generally valid templates (Hirschauer & Mußhoff 2012).

Both measures lead to the result, that the ITW2-scenario started in 2021 shows the highest possible CM, followed by the ITW1-scenario. This indicates that the farmer did the right decision in regard to the profitability of the business segment fattening pigs participating in the ITW1 in 2018, otherwise, he would have lost 40 cents/pig. The hypothesis that the participation in the ITW might be a risk management instrument for the analyzed farm can be confirmed: with a hedging effectiveness of 11,20 % compared to the control scenario, the participation in the ITW leads to a reduction of fluctuations of the CM for the farmer under the assumptions made for the analysis. The disclosure of percentiles and value-at-risk figures underpin this finding. Differences in results between the two applied stochastic measures can be observed in the disclosed potential negative CM and the middle 50 %-intervals which are more detailed for the stochastic simulation due to the law of large numbers. So, farmers might not be only participating in a welfare program because of economic advantages, also due to risk reducing effects which have to be carried out farm individually.

Because the risk attitude of the farmer and how the farmer evaluates a certain risk reduction are not processed in the simulations, a direct recommendation for action cannot be made. Thus, the hedging effectiveness is, as a benchmark to quantify the risk reduction potential of a risk management instrument, an appropriate measure as an alternative for decision making (Urban 2019). Subsidizing FAW through direct payments often has the risk of the “free rider” behavior which does not lead into essential improvements in FAW (Spiller et al. 2010). Whereas the ITW ensures a guaranteed purchase of piglets produced under the ITW standards and fattening pigs because slaughterhouses, food intermediaries and the food retailing are taking part equally (ITW 2020c) and by that reducing and sharing the marketing risk by various actors. For example, in the ITW2 program phase, it is mandatory for piglet farmers to take piglets from farmers keeping sows who have an ITW delivery authorization. Farmers with fattening pigs do not have to take ITW-piglets yet but have supply agreements with participating slaughterhouses (ITW 2020c). Here, the farm manager of the analyzed farm assumes a potential risk in the future regarding stricter regulations purchasing piglets. The uncertainty about political decisions, like potential size limits, intensifies this perception, whereby the farmer evaluates changes in regard to the purchase of piglets with a low probability of occurrence

and a low amount of damage for his farm. Whereas the political risk plays a more significant role for him (Farm manager 2020). The risk reduction due to the payed fix price of earlier 5,10 €/pig and since 2021 5,28 €/pig which cover the incidental costs, works via the market which is why the ITW payment cannot be seen as direct subsidizing. The utility of the ITW is ceteris paribus high, the higher the risk reduction is and/ or the lower the extra costs are.

Nonetheless, risk management strategies and instruments should always be seen in conjunction with each other because they can mutually reinforce each other or reduce their effects (Hirschauer & Mußhoff 2016). The farmer of the analyzed farm highlights in the interview the importance of the mixture of risk management instruments as he is implementing the following ones: an ensured feed supply, own feed cultivation, an assured animal care combined with staff training to guarantee a high level of quality of care, structural safety, a low level of specialization and long value-added chains to hedge negative business growths, contractual commitments to buyers, as well as two shareholders for the whole farm (Farm manager 2020). Furthermore, it should be noticed that a solely reduction of input prices does not always mean a reduction of volatility of the target figure, as shown under 4.2.3. The positive correlation of pig and piglet prices with a correlation coefficient of 0,73 leads to a natural hedge.

Besides the economic aspects of the risk reduction of the FAW-program ITW, there are two further aspects in FAW which can lead to reduced risks. One aspect are potential improved biological performances caused by lower stock densities and enhanced well-being due to more offered materials to manipulate. Several studies investigated the effect of different housing systems on fattening pigs. The results show slightly lower daily gains and feed conversion, due to a higher energy need for the thermoregulation of the animals, but an improve in animal health in housing systems with more space per animal and more manipulable material, as offered for instance in straw-based systems, which for example can lead to less veterinary costs (Mayer et al. 2006; Pflanz 2012; Weber 2003). Müller & Gräfe (2019) found out that due to expanding the supply of space, the loss rate decreased while the growth performance increased. Those improvements have the potential to compensate up to one third of the

higher fix costs of the in this study implemented FAW measures. Other studies could not verify the argument of a correlation between the animal density and FAW indices (Knage-Rasmussen et al. 2013; Lawrence 2013). Meyer-Hamme (2015) concluded, that farm management, the choice of the feeding system and floor types are more relevant factors to examine in combination with herd size in regard to FAW.
Another aspect is the less amount of manure per hectare due to lower amounts of kept animals. Almost every FAW program implies space requirements which force the farmers to reduce the animal densities. In combination with stricter provisions for the fertilization, especially in areas with a high livestock density, which can lead to cost increases caused by applying too much liquid manure, positive synergies can be used (Dittert 2020). That is where agroecological approaches come into the picture, taking a whole-system approach and trying to achieve a needs-based nutrient cycle with lower nutrient losses (Gliessman 2015).

With respect to future changes in business in relation to more FAW on his own farm, the manager of the analyzed farm is open minded to do larger investments in FAW but the “commercialization problem finding marketing partners who would pay for the additional costs” (Farm manager 2020) is currently for him the major obstacle to take further steps in this direction. Many primary producers cannot avoid changing from cost leadership towards quality leadership to generate extra charges ensuring long-term operational viability (Sundrum 2018). Often the marketing of high-quality products is an obstacle for farmers, whereas a funded network of consultants for instance or boosting innovative marketing projects to ensure a long-term finance through the market may support such a marketing. A remained consumer-citizen-cap which cannot be completely solved via the market, leads to necessarily goal-oriented agro-political funding covering the extra costs of higher FAW standards, especially compensating the competitive disadvantage if the FAW standard in Germany is higher than the European one (Borchert-Commission 2020). The established existing network of the ITW can be further used strategically and expanded by including all food retailers, more slaughterhouses and the gastronomy. Closer forms of cooperation might be preferable to exploit the value-added potential for farmers

more, as for instance by means of marketing counting houses (Spiller et al. 2005). The attractivity participating in FAW needs to be increased for other sectors of the food system, too. Hortmann-Scholten (2019) indicates a qualitative growth regarding pork instead of increasing stock size. The challenge of commercializing FAW products can be seen in the proliferation of the market with labels, whereby labels have potential to lead to higher consumer willingness-to-pay as already described in section 2.1.3. Simultaneously it is to be expected that husbandry systems with free ventilation, separated functional areas, more space and, where applicable, with yards will be come into effect (Neser & Grimm 2019), while major questions about emission standards and financing more FAW have to be responded to. Several finance strategies for more FAW, presented under 2.1.4, exist, whereby the Borchert-Commission (2020) calculates with 1,2 to 3,6 billion euros depending on the level of FAW and the WBA (2015) with 3,0 – 5,0 billion euro costs for implementing the respective suggested standards. From the perspective of the farmer, political interference should not be the financier of more FAW, he claims for a market solution via consumer behavior (Farm manager 2020). Working on the societal perception of the livestock farming sector and therefore influencing the purchasing behavior of consumers is another approach to raise the market share for products produced under high FAW standards (Simons 2019). Additionally, the farmer evaluates the ongoing corona crises, with e.g. potential closures of slaughterhouses, and the ASF, mentioned in the introduction, as two essential risks with a relatively high amount of damage and probability of occurrence. The change in nutrition towards more plant based food items is for the farmer a risk which needs to be considered as well, whereby he values the probability of occurrence higher than for the other risks but thinks the changes in dietary behavior will not have such a huge extent of damage on his farm (Farm manager 2020).

Shifting from a national level towards the European level, the EU have to rethink its strategy and endeavor to initiate an open dialogue with all stakeholders involved, including the general public, the different actors of the value chain meat, the science encompassing breeding, husbandry systems and management, as well as those responsible for building trade, fertilizer ordinance

and pollution control, to keep its license to produce in the long run. However, there is the risk that the European livestock sector will decrease its potential “of gaining a competitive advantage as a global animal welfare leader” (Busch et al. 2018: 1999). In Germany for example, already both developments can be observed: on the one hand, there are efforts to achieve a common and feasible level of FAW. On the educational level there was for instance the doctoral program “Animal Welfare in Intensive Livestock Production Systems” of the University in Göttingen, on practical level, examples are the prevalence of mobile barns for hens or the foundation of the association for the “Promotion of open stable husbandry for pigs” which supports FAW-friendly stables and helps to market the produced meat. The ITW as cross-sectoral alliance of the agricultural industry tries to achieve a market-based solution for promoting FAW, whereas on the political level the BMEL plans a state label for FAW. On the other hand, the structural change in the German pig sector, illustrated by means of Figure 7, or the planned establishment of a slaughterhouse with a processing plant in Spain by Tönnies (Topagrar online 2020b) indicate an out-migration of the national pork production abroad. The livestock farming sector in Germany is an important economic cornerstone for the agricultural business and therefore, according to representatives of the German Farmers´ Federation, the business has to be kept in Germany (DBV 2020).

The discussion about FAW leads to system thinking, linking sustainable development of food production with processing, market trends and consumer behavior, considering all relevant components and their interactions in the food system. Thereby, agroecological approaches, even if they are relatively new in public agricultural debates, can contribute valuable holistic concepts, as the stated participatory approaches.

Nevertheless, there is still need for research in the field of analyzing the profitability of FAW programs like the ITW, also in regard to risk management. More on-farm studies are necessary to examine under which circumstances FAW-programs are more profitable or rather which factors determine the profitability of FAW programs the most. Further, a larger amount of studies allows more representative results. Prospective research projects could as well consider regional characteristics, like animal densities, because the livestock

density in Northwest and Southwest Germany in relation to the area is relatively high. Parties who are developing higher FAW standards can fall back on these studies to develop feasible and effective requirements. Business segment accounting is an appropriate measure to compare various farms with different factory equipment and performance parameters which each other. Risk-reducing effects of higher FAW standards have to be analyzed more in detail to assess possible potentials of FAW programs against the background of an operating environment dealing increasingly with various risks. This should include analyzing possible side effects of participating in an FAW program on other business segments and on the whole risk profile of a farm, like including the effects of less manure per hectare or to consider a potential risk compensation between animal husbandry and plant production. Also, including possible risk-reducing impacts of potential healthier animals of FAW programs have to be integrated in historic and stochastic simulations whereby especially the latter one is suitable for integrating detailed information. For instance, regarding the German state label, this would mean including higher costs for piglets due to a longer lactation phase which results in higher feeding costs and incidental costs for nesting material, both mandatory requirements in the state label. Additionally, costs for storing materials like pellets or roughage need to be considered for an encompassing extra cost accounting as well. Varying the payed renumeration for future planned FAW programs is an interesting object of investigation as well. The quantitative risk management could be extended by considering the individual risk attitudes to give concrete recommendations for action in the end. Such detailed scenario analyses and cost accountings, also between different FAW programs, are necessary to conclude more realistic and specific impact assessment offering livestock farmers comprehensive planning foundations.

6 Conclusion

In recent years, the German livestock sector lost social acceptance and animal welfare (FAW) became a contentious, increasingly public debated, issue. Simultaneously, stricter environmental requirements, changes in consumer´s nutritional behavior, in general fluctuating pig and piglet prices, many pivotal political decisions and currently the ASF influenced the livestock farming business.

This master thesis lays its focus on the German animal welfare label “Initiative Tierwohl” (ITW) as the first cross-sectoral alliance of the agricultural industry, the meat industry and the food retailing, trying to initiate a change in the livestock farming sector via financial support of the food retailing with the long-term goal of achieving a completely market-led label. The aim of this thesis was to analyze animal welfare initiatives regarding their profitability and effects as risk management instruments. To enable these investigations, one fattening pig farm with 10.400 animal places participating in the second program phase of the ITW from 2018 to 2020 (ITW1) was the object of investigation. The analyzed farm represents a conventional fattening pig plant implementing the ITW1 criteria “10 % more space”, “additional manipulable material” and “permanent access to roughage”. In total, three animal welfare programs were examined: the ITW from 2018 to 2020 (ITW1), the ITW from 2021 to 2023 (ITW2) and the planned German state label as a comparative scenario.

The performed calculations and historic and stochastic simulations showed that the German state label leads to the highest annual and singular investment costs per pig and an assumed renumeration of 6 €/pig payed to the farmer would not be enough for covering the extra costs. The renumeration of the ITW1 is sufficient for covering incidental extra costs, whereby the opportunity costs for keeping lower amounts of animals remain the highest cost position. Participating in the ITW1 lead to a plus in Dcfp for the farm and in this specific case to a reduced volatility of the contribution margin. The hedging effectiveness of 11,20 % of the two ITW-scenarios compared to the control scenario, where the farm is not taking part in an FAW program, is against the background of an increasingly risky environment, an important factor for this farm´s prospective planning horizon. Additionally, a price scenario analysis showed at a price constellation of 1,60 €/ kg carcass weight, piglet prices up to 50 €/28 kg piglet

and feed prices till 25 €/dt, a participation in the ITW1 might be unprofitable. Whereas it is necessary to take account of increased fix costs per pig of the respective farm when implementing FAW with space requirements.

The methods used in this thesis are appropriate to determine the cost structures and profitability as well as the risk reducing potential of the FAW programs for the farm investigated in this paper. Caution however should be made when conclusions are drawn from the results of the analyzed farm to other farms and FAW programs. The calculations are based on various assumptions and therefore cannot replace the individual factor endowments and individual risk attitudes that are needed to be taken into account as especially these factors are determining the key figure of profitability of an on-farm FAW program and of the choice participating in one.

7 References

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8 Declaration of authorship

Hereby, I, Jana Zibolka, born 30th September 1996 in Schönebeck (Elbe), declare that the enclosed master thesis “Profitability of animal welfare – A German pig fattening business participating in the German animal welfare initiative ´Initiative Tierwohl´” is my own unaided work. All direct or indirect sources used are acknowledged as references. I am aware that the thesis in digital form can be examined for the use of unauthorized aid and in order to determine whether the thesis as a whole or parts incorporated in it may be deemed as plagiarism. This thesis was not previously presented to another examination board and has not been published.

Göttingen, 17.03.2021

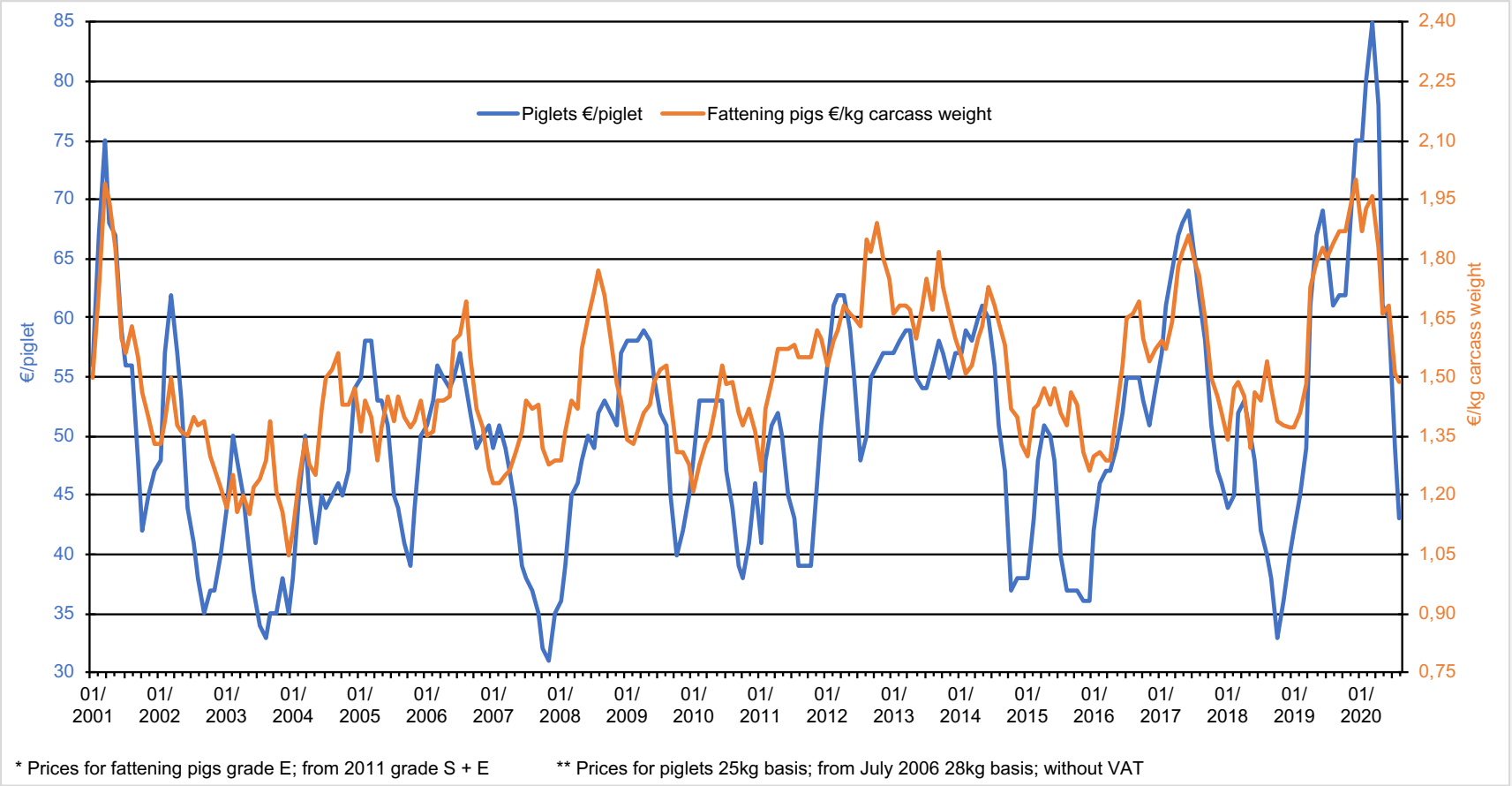
9 Appendix

Appendix 1: Illustrations of implemented criteria by the analyzed farm "additional manipulable material" and "roughage"

Photo 1: Straw pellet (Zwicker et al. 2013: 3)

Photo 2: Manipulable material wood at a chain (Wiedmann 2016: 21)

Appendix 2: Monthly price development of prices for piglets and fattening pigs from 2001 to 2020 (own figure based on AMI 2002a-2020a; AMI 2002b-2020b; BLE 2020b)



* Prices for fattening pigs grade E; from 2011 grade S + E

** Prices for piglets 25kg basis; from July 2006 28kg basis; without VAT

Table A 1: Future proposals for the design of higher FAW standards in Germany by the WBA (2015) and the Borchert-Commission (2020)

Nine Guidelines for higher FAW standards of the WBA*	Borchert-Commission**
(1) access of all livestock to various climate zones, preferably including outdoor climate **(2)** provision of different functional areas with various floor coverings **(3)** provision of installations, substances and incentives for species-specific activities, feed intake and grooming activities **(4)** provision of sufficient space **(5)** a halt to amputations **(6)** routine farm self-inspections based on animal-related animal welfare indicators **(7)** a clear reduction in the use of medicinal products **(8)** improved level of education, knowledge and motivation of people working in the livestock sector **(9)** greater consideration of functional characteristics in breeding	**Level 1**/stable plus: more space; more manipulable materials etc. **Level 2**/improved stables: additional space; structuring; climate zones preferably with outdoor climate; partly solid floors; new stables with outdoor climate access; modifications preferably with contact to outdoor climate **Level 3**/premium: more space as on level 1 and 2; yard or pasture grazing (cattle, poultry). The standard of this level is oriented towards the criteria of ecological farming.

* The German Scientific Advisory Board on Agricultural Policy (WBA) calculates with 3 - 5 billion Euro per year for the implementation of those guidelines for all livestock farmers in Germany. This would mean an increase in consumer price of around 3 % to 6 % (WBA 2015).

** The Borchert-Commission (2020) orients itself on the future three stepped governmental animal welfare label of the BMEL and on level 2 to 4 of the label “Haltungsform” of the food retailing. The costs calculations amount to 1,2 billion Euro in 2025, 2,4 billion Euro in 2030 and 3,6 billion Euro in 2040. In 2025 at least 50 % of the livestock production should be on level 1, at least 10 % on level 2. In 2030, level 1 should be legal minimum standard and at least 40 % of livestock production should be on level 2. In 2040, level 2 will be the new legal minimum standard and at least 10 % of level 3 should be realized. The idea to cover higher production costs is a combination of premiums for all three levels and investment promotion for level 2 and 3 to support farmers.

Table A 2: ITW1 cataloque of criteria for fattening pigs, piglet rearing and sows 2018-2020 (ITW 2020c)**

Block A: Basic requirements					
Pig fattening		**Piglet rearing**		**Sows keeping**	
Basic criteria:	500 € tax-free allowance	Basic criteria:	500 € tax-free allowance	Basic criteria:	500 € tax-free allowance
QS*-antibiotics-monitoring		QS-antibiotics-monitoring		QS-antibiotics-monitoring	
QS-slaughtering results		Health plan		Health plan	
Stable climate check		Stable climate check		Stable climate check	
Drinking water check		Drinking water check		Drinking water check	
Daylight		Daylight		Daylight	
Additional manipulable material		Additional manipulable material		Additional manipulable material	
10 % more space		10 % more space		10 % more space for groups	
Sum of basic criteria	3,30 €	Sum of basic criteria	0,95 €	Sum of basic criteria	2,00 €
Block B: Facultative additional option and criteria are separately selectable					
In total 20 % more space (payment additional to Block A)	1,20 €	In total 20 % more space (payment additional to Block A)	0,40 €	In total 20 % more space (payment additional to Block A)	0,80 €
Roughage	1,80 €	Roughage	0,40 €	Roughage/ nest-building material	0,80 €
Rubbing opportunities	0,60 €	Rubbing opportunities	0,40 €	Rubbing opportunities	0,05 €
Air cooling device	0,20 €	Microclimate area	0,20 €	Sows in groups	0,80 €
Drinking from open surfaces	0,70 €	Drinking from open surfaces	0,40 €	Drinking from open surfaces (group)	0,07 €
				Drinking from open surfaces (farrowing room)	0,18 €
Sum B	**4,50 €**	**Sum B**	**1,80 €**	**Sum B**	**2,70 €**
Maximal sum	**5,10 €**	**Maximal sum**	**1,35 €**	**Maximal sum**	**2,80 €**

* **QS – Qualitätssicherung-label**

** **A comprehensive explanation of the catalogue of criteria can be found at: ITW (2020c)**

Table A 3: ITW2 cataloque of criteria for fattening pigs, piglet rearing and sows 2021-2023 (ITW 2020g)

Mandatory requirements		
Pig fattening	**Piglet rearing****	**Sows keeping**
Basic criteria:	Basic criteria:	Basic criteria:
QS-antibiotics-monitoring	QS-antibiotics-monitoring	QS-antibiotics-monitoring
QS-slaughtering results	Health plan	Health plan
Stable climate check	Stable climate check	Stable climate check
Drinking water check	Drinking water check	Drinking water check
Training measures*	Training measures*	Training measures*
Daylight	Daylight	Daylight
10 % more space	Purchase of ITW-piglets*	10 % more space
Roughage*	Roughage*	Roughage*
5,28 €/ fattening pig	**3,07 €/ piglet**	**1,80 €/ weaned piglet**

* **New/ changed criteria**

** **The criteria "10 % more space" is only mandatory for fattening pigs and sows due to the novelty that piglet rearing and sows keeping is seen as an unit. The reduction of sows simultaneously will lead to a reduced number of piglets in the downstream business (ITW 2020g).**

Table A 4: Scheme of business segment accounting for fattening pig business based on DLG (2004)

	Performance type/ Cost type	Performances Direct costs Overhead costs [€]	Factor costs, Adjusted amounts	Sum per unit of reference value [€/kg carcass weight] / [€/pig]
Performances	Animal sales (Pigs > 50 kg)			
	Piglet sales (25 – 50 kg)			
	ITW payment			
	Inventory changes			
	Manure value			
	Other operational earnings			
Sum of performances				
Direct costs	Piglets purchase			
	Veterinarian, medicines			
	Water			
	Electricity			
	Animal diseases fund			
	Animal insurance			
	Cleaning, disinfection			
	Concentrated feed			
	Dead animals/ Disposal			
	Incidental expenses pigs			
	Fees slaughterhouses 19 %			
	Purchased services			
	Other material			
	Interest rates			
Sum of direct costs				
Direct cost-free performance				
Employment-related costs	Personnel costs			
	Management/ administration			
	Maintenance structural facilities			
	Maintenance operating facilities			
	Raw-, auxiliary-, operating materials			
	Other cost of materials			
	Fuels and lubricants			
	Diesel fuel			
Sum of employment-related costs				
Building costs	Maintenance farm buildings			
	Depreciation (of immaterial assets, of tangible assets, farm buildings, Immediate depreciation)			
Sum of building costs				
Other costs	Dues, Fees			
	Other charges			
	Bookkeeping, consultancy			
	Office, administration			
	Others			
Sum of other costs				
Sum of costs				
Balance of performances and costs				
Trade tax				

Table A 5: Assumptions for calculation of additional costs for farmers participating in ITW1 2018-2020[32]

		Roughage	Manipulable material wood
Amount per animals		1 : 20	1 : 20
Amount per livestock area	pieces	2	2
Total amount	pieces	1.280	1.280
Purchase price	€/piece	20,00	10,00
Installation costs (assumed wage: 17,50 €/h; assumed installation time: 15 min/piece)	€/piece	4,38	4,38
Singular investment costs	€/piece	24,38	14,38
Total singular investment costs	**€**	**31.200,00**	**18.400,00**
Usage straw pellets per dispenser/ wood	g/d/pig or wood/a	30	1
Price per piece	€/kg or €/wood	0,90	0,60
Annual investment costs without costs of annual extra work	€/a	28.304,64	768,00
Working hours (assumption: 2min/ replacement straw pellet per dispenser; 12min/exchange wood)	h	555	256
Annual labor costs (assumed wage: 17.50 €/h)	€/a	9.706,67	4.480,00
Annual labor costs management (assumption: 2min/animal place/a for planning, training, documentation, etc. plus 5,5h audit per year)	€/a	5.556,25	
Total annual costs	**€/a**	**38.011,31**	**5.248,00**
Total annual costs (plus annual labor costs management)	**€/pig/a**	**1,80**	

[32] Sources: BayWa (2020), Ecora-online-online (2020), Farm manager (2020), GFS-Topshop (2020), ITW (2020c), Stalltechnik24 (2020), Heise & Schukartha (2019), Achilles et al. (2016), KTBL (2014)

Table A 6: Assumptions for calculation of additional costs for farmers participating in ITW2 2021-2023[33]

		Roughage
Amount per animals		1 : 20
Amount per livestock area	pieces	2
Total amount	pieces	1.280
Purchase price	€/piece	20,00
Installation costs (assumed wage: 17,50 €/h; assumed installation time: 15 min/piece)	€/piece	4,38
Singular investment costs	€/piece	24,38
Total singular investment costs	**€**	**31.200,00**
Usage straw pellets per dispenser	g/d/pig	30
Price per piece	€/kg	0,90
Annual investment costs without costs of annual extra work	€/a	28.304,64
Working hours (assumption: 2min/ replacement straw pellet per dispenser)	h	555
Annual labor costs (assumed wage: 17,50 €/h)	€/a	9.706,67
Annual labor costs management (assumption: 2min/animal place/a for planning, training, documentation, etc. plus 5,5h audit per year)	€/a	5.556,25
Total annual costs	**€/a**	**43.567,56**
Total annual costs	**€/pig/a**	**1,61**

[33] Sources: BayWa (2020), Ecora-online-online (2020), Farm manager (2020), GFS-Topshop (2020), ITW (2020c), Stalltechnik24 (2020), Heise & Schukartha (2019), Achilles et al. (2016), KTBL (2014)

Table A 7: Assumptions for calculation of additional costs for farmers participating in the planned German state label[34]

		Roughage	Manipul-able material wood	Pellet dispenser	Rubber mats	Drinking from open surface	Rubbing equipment
Amount per animals		1 : 20	1 : 20	1 : 20	-	1 : 12	1 : 50
Amount per livestock area	pieces	2	2	2	7 (1 mat = 1m^2)	3	1
Total amount	pieces	1.280	1.280	1.280	4.480	1.920	640
Purchase price	€/piece or €/m^2	20,00	10,00	130,00	35,00	60,00	26,00
Installation costs (assumed wage: 17,50 €/h; assumed installation time: 15 min/piece; 30 min/piece for drinking device)	€/piece	4,38	4,38	4,38	4,38	8,75	4,38
Singular investment costs	€/piece	24,38	14,38	134,38	39,38	68,75	30,38
Total singular investment costs	**€**	**31.200**	**18.400**	**172.000**	**176.400**	**132.000**	**19.440**
Usage straw pellets per dispenser/ wood	g/d/pig or wood piece/a	30	1	20	-	-	-
Price per piece	€/kg or €/wood piece	0,90	0,60	0,90	-	-	-
Annual investment costs without costs of annual extra work	€/a	28.304,64	768,00	52.985,09	-	-	-
Working hours (assumption: 2min/ replacement straw pellet per dispenser; 12min/exchange wood; 1min/ filling up pellet dispenser every fourth day; 0,01min/10 pigs/d cleaning)	h/a	555	256	1.941,33	147	147	-
Annual labor costs (assumed wage: 17,50 €/h)	€/a	9.706,67	4.480,00	33.973,33	2.572,50	2.572,50	-
Annual labor costs management (assumption: 2min/animal place/a for planning, training, documentation, etc. plus 5,5h audit per year)	€/a	4,853.33					
Total annual costs	**€/a**	**38.011,31**	**5.248,00**	**86.958,42**	**2.572,50**	**2.572,50**	**0,00**
Total annual costs (plus annual labor costs management)	**€/pig/a**	**5,81**					

[34] Sources: BayWa (2020),BMEL(2020a), Ecora-online-online (2020), Farm manager (2020), GFS-Topshop (2020), ITW (2020c), Stalltechnik24 (2020), Heise & Schukartha (2019), Achilles et al. (2016), KTBL (2014)

Table A 8: ITW1 (2018-2020) profitability under different price scenarios - depending on slaughter revenues, piglet costs and feed costs (1)

Fattening pig prices €/kg	Piglet prices €/28kg	Feed prices €/dt		
		20 dt	25 dt	30 dt
		Loss of Dcfp €/pig		
1,20	30	0,17	1,51	2,84
	40	1,16	2,50	3,83
	50	2,17	3,51	4,84
	60	3,16	4,50	5,83
	70	4,17	5,51	6,84
	80	5,16	6,50	7,83
1,30	30	- 0,79	0,55	1,89
	40	0,21	1,54	2,88
	50	1,20	2,55	3,89
	60	2,21	3,54	4,88
	70	3,20	4,55	5,89
	80	4,21	5,54	6,88
1,40	30	- 1,74	- 0,41	0,93
	40	- 0,73	0,59	1,92
	50	0,26	1,58	2,93
	60	1,25	2,59	3,92
	70	2,26	3,58	4,93
	80	3,25	4,59	5,92
1,50	30	- 2,70	- 1,36	- 0,03
	40	- 1,69	- 0,35	0,97
	50	- 0,70	0,64	1,96
	60	0,30	1,63	2,97
	70	1,29	2,64	3,96
	80	2,30	3,63	4,97
1,60	30	- 3,66	- 2,32	- 0,98
	40	- 2,65	- 1,31	0,02
	50	- 1,66	- 0,32	1,01
	60	- 0,65	0,68	2,02
	70	0,34	1,67	3,01
	80	1,33	2,68	4,02
1,70	30	- 4,62	- 3,28	- 1,94
	40	- 3,61	- 2,27	- 0,93
	50	- 2,62	- 1,28	0,06
	60	- 1,61	- 0,28	1,05
	70	- 0,62	0,72	2,06
	80	0,38	1,72	3,05

Table A 9: ITW1 (2018-2020) profitability under different price scenarios - depending on slaughter revenues, piglet costs and feed costs (2)

Fattening pig prices €/kg	Piglet prices €/28kg	Feed prices €/dt		
		20 dt	25 dt	30 dt
		Loss of Dcfp €/pig		
1,80	30	- 5,57	- 4,23	- 2,90
	40	- 4,56	- 3,22	- 1,89
	50	- 3,57	- 2,23	- 0,90
	60	- 2,56	- 1,23	0,10
	70	- 1,57	- 0,23	1,10
	80	- 0,56	0,77	2,10
1,90	30	- 6,53	- 5,19	- 3,85
	40	- 5,52	- 4,18	- 2,84
	50	- 4,53	- 3,19	- 1,85
	60	- 3,52	- 2,18	- 0,85
	70	- 2,53	- 1,19	0,15
	80	- 1,52	- 0,18	1,15
2,00	30	- 7,49	- 6,15	- 4,81
	40	- 6,48	- 5,14	- 3,80
	50	- 5,49	- 4,15	- 2,81
	60	- 4,48	- 3,14	- 1,80
	70	- 3,49	- 2,15	- 0,81
	80	- 2,48	- 1,14	0,19

Profitability of animal welfare – recommendations for designing a farm animal welfare initiative

Jana Zibolka

Background

In recent years, the German livestock sector lost social acceptance and animal welfare (FAW) became a contentious, increasingly public debated, issue. Increasing numbers of people are concerned about the conditions of predominant husbandry systems as well as the structure of the whole meat industry, including for instance both the regional concentration of livestock farmers and the vertical concentration of meat processors. Lately, this was for instance the present scandal of several onsets of the severe acute respiratory syndrome (SARS) coronavirus in German slaughterhouses (WBA 2015). Simultaneously to this development, stricter environmental requirements, changes in consumer´s nutritional behavior, in general fluctuating pig and piglet prices mainly due to the general market liberalization, several pivotal political decisions and currently the African Swine Fiver influence the livestock farming business. Especially agricultural businesses have to deal with diverse risks, also due to the dependence of natural uncertainties in the production process. These risks effect a lack of information, which raise the question of hedging the interlinked impending consequences. For one thing, an aimed risk management includes measures to reduce unacceptable fluctuations of the business success, then again it provides a basis of decision-making for strategic considerations about several action alternatives (Hirschauer & Mußhoff 2012; Frentrup et al. 2014). The willingness to pay for animal welfare-friendly products is increasing, while until now there is only one market-based farm animal welfare (FAW) label in Germany, the “Initiative Tierwohl” (ITW). This initiative is the first cross-sectoral alliance of the agricultural industry, the meat industry and the food retailing. From farmers´ perspective, FAW will be one decisive issue in the long-term, whereby an increased willingness to implement FAW can be observed (Heise 2016).

Fig.1: Label of the German “Initiative Tierwohl”

Policy recommendation

Several studies about cost calculations and scenario analyses of different FAW measures, like Zibolka (2021), Schukat & Heise (2019a) and DLG (2016), showed the difficulty to generalize the achieved results.

Because risk management is increasingly taken into account, concepts incorporating risk analyses with economic assessment of FAW measures on farm specific level considering market data are necessary.
The results of the thesis of Zibolka (2021) showed, applying such an approach, can lead to a more comprehensive view on on-farm effects coming from participating in a FAW program, in this case the ITW. Taking part in the ITW lead to a hedging effectiveness of the contribution margin of about 11 % compared to a scenario without taking part. Besides the incidental extra costs for implementing the required criteria, like permanent access to roughage or offering additional manipulable material, the opportunity costs for keeping lower amounts of animals due to space requirements have to be considered. Almost every FAW program involves the criteria “more space per animal”, so that depending on the current market prices, these costs can vary greatly. A listening of all extra costs, labor costs, maintenance costs and singular investment costs has to be contrasted with the payed renumeration. Initiators of FAW programs should focus on communicating the holistic mode of action of a participation in such a program for farmers. This includes presenting potential side-effects pointing out diverse marketing strategies, possible positive synergy effects of less manure due to lower amounts of kept animals on the compliance of fertilization regulations, and impact effects on the risk management of farming businesses, including other business segments. Communicating an ensured financing of the high singular investment costs and guaranteed practical realization of FAW-stables against the background of emission standards is indispensable to reduce the investment shyness of German farmers amidst uncertain political behavior and to create incentives for farmers with a low level of FAW participating in voluntary FAW programs. The durability of FAW programs has to be ensured to give farmers security of investment. The development of a planning tool containing information about market data, price trends, considering entering of farm specific data and potential options for higher FAW, and using existing databases would be desirable. With advisory and such an all-encompassing approach, offering more planning security, farmers could be convinced more easily by a voluntary FAW program.

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