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Costs and benefits of a welfare label in pig feeding

Management and housing conditions have an effect on the welfare of feeding pigs, which is why appropriate minimum standards are legally defined. Additional welfare resources such as more space and outdoor runs are associated with more costs. In the study presented here, the costs of the additional requirements are quantified and the effects on the feeding pigs evaluated using examples of the requirements of the welfare label “For more animal protection” and for production under the EU Organic Farming Directive (EU-eco-regulation). The calculations for the welfare label result in additional costs of from 20 to 35 cent per kg slaughter weight in comparison to costs for conventional products. Measured against the figures in the National Evaluation for Animal Production Systems none of the models evaluated satisfied the highest animal welfare requirements.

Keywords

Animal welfare, costs, housing conditions, labeling, pig feeding, livestock housing

Abstract

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■ Animal protection in welfare terms for farm livestock has been based mainly over the past decades on the resources offered, e. g. amount of available space. Feeding pigs are included among animals for which legal requirements were already formulated 30 years ago. The Farm Animal Welfare Order [1] formulates requirements for production facilities and the husbandry of feeding pigs. In practice the feeding pig producer orientates production mainly on the minimum legal requirements because the range of possible additional welfare resources is associated with higher costs. The aim of labelling schemes is to compensate higher production costs through higher returns from systems that are particularly welfare-based.

Within a project of the Federal Office for Agriculture and Food (BLE) the prospects for a European Animal Welfare label were investigated [2]. The authors quantified the market represented by consumers interested in animal welfare, and willing to pay for it, at 20 % of the population in Germany and evaluated the prospects of an animal welfare label as positive. On this basis the German Animal Welfare Association has undertaken responsibility for an animal welfare label. Since mid-January 2013 the first pig meat products with the label “For more animal welfare” have been on the market.

Because, so far, very few analyses of costs involved in German animal welfare labelling have been publicised, the costs associated with the label requirements, and the benefits in terms of animal welfare from resource-based measures, are investigated.

Procedural models and method

The animal protection label “For more animal welfare” includes an entry-level standard and a premium standard. Compared with conventional production the former requires a significantly larger pen floor area per animal, a mat on the lying area or litter and activity material with straw and spray cooling. The premium standard differs from the entry standard through, among other things, an outdoor run as well as straw litter in the activity area.

Based on the KTBL databank, a procedural model was created for each of the two standards according to the requirements of the animal welfare label “For more animal welfare” [3] (Table 1). Both these models were compared in each case with a planning example for conventional pig feeding and for pig feeding according to organic farming rules. While the model “conventional” was oriented on the minimum legal requirements of the Farm Animal Welfare Order, the model “production according to the EU Organic Farming Directive” offered, among other things, rooting possibilities and the feeding of forage in addition to an outdoor run and more floor space. All four models are based on pig housing models from the KTBL online facility “Building costs” [4] as well as the minimum standards in each case [1; 3; 5; 6].

Referred to in cost analyses is the performance-cost accounting in farm business planning [7] with all individual costs in-

Table 1

Description of the four method models for the production of various animal welfare standards

Merkmal Attribute	Konventionell Conventional	Tierschutzlabel/Animal welfare label		Erzeugung nach EG-Öko- Verordnung Organic farming
		Einstiegsstandard Entry standard	Premiumstandard Premium standard	
Gebäudetyp Type of building	geschlossener Stall closed house	geschlossener Stall closed house	Außenklimastall open climate house	Außenklimastall open climate house
ID/ID	MS 25001	MS 25002 ¹⁾	MS 37003 ¹⁾	MS 39003 ¹⁾
Buchtenfläche Area of pen [m ² /TP]	0,75	1,10	1,00	1,30
Auslauf/Yard [m ² /TP]	-	-	0,50	1,00
Liegefläche Laying surface	vollperforiert slatted floor	Gummimatte rubber mat	planbefestigt mit Einstreu solid floor with litter	planbefestigt mit Einstreu solid floor with litter
Entmistungstechnik Manure management	Flüssigmist liquid manure	Flüssigmist liquid manure	Festmist solid manure	Festmist solid manure
Gruppen [Tiere/Bucht] Groups [animals/pen]	40	27	22	Vormast/Pre-feeding: 40 Endmast/Finishing: 20
Spezielle Stalleinrichtung Special equipment	Nippeltränke Nipple drinkers	Nippeltränke, Sprühkühlung, Beschäftigungsautomat Nipple drinkers, spray cooling, play automatic	Schalentränke, Scheuerbalken cup, scrub bar	Schalentränke, Scheuerbalken, Raufe cup, scrub bar, hay rack
Futter Feed	konventionell conventional	konventionell conventional	GVO-frei GMO free	ökologisch organic
Grobfutter/Roughage	-	Stroh/straw	Stroh/straw	Stroh, Silage/straw, silage

TP = Tierplatz/Animal place

¹⁾ Bestandsgröße verändert/Stock numbers altered.

Table 2

Selected efforts and costs per animal place and year

Merkmal Attribute	Einheit Unit	Konventionell Conventional	Tierschutzlabel/Animal welfare label		Erzeugung nach EG- Öko-Verordnung Organic farming
			Einstiegsstandard Entry standard	Premiumstandard Premium standard	
Gebäudetyp/Type of building ¹⁾		geschlossener Stall closed house	geschlossener Stall closed house	Außenklimastall open climate house	Außenklimastall open climate house
	ID/ID	MS 25001	MS 25002 ²⁾	MS 37003 ²⁾	MS 39003 ²⁾
	TP	960	972	902	960
	€/TP	433	612 ³⁾	496	623
	€/(TP · a) ⁴⁾	36,62	51,96	41,22	48,97
Arbeit/Labour	AKh/(TP · a)	0,76	1,16	1,66	2,27
	€/(TP · a) ⁵⁾	11,40	17,33	24,90	34,05
Stroh/Straw	kg/(TP · a)	-	6,5 ⁶⁾	228 ⁷⁾	228 ⁷⁾
	€/(TP · a) ⁸⁾	-	0,85	28,44	30,71
Maschinen/Machinery	€/(TP · a)	0,21	0,21	14,20	21,87
Summe/Sum	€/(TP · a)	48,23	85,41	108,76	135,60

TP = Tierplatz/Animal place

¹⁾ Stallmodell-ID gemäß KTBL Online-Anwendung Baukost/Housing model ID according to KTBL online tool Baukost ²⁾ Bestandsgröße verändert/Stock numbers altered.³⁾ Basiswert Gebäude 417 €/TP, 1400 TP, Faktor Baukostenanpassung Buchtenfläche 1,47/Base value buildings 417 €/TP, 1400 TP, factor building cost in relation to pen areas 1.47.⁴⁾ Abschreibung für langfristig/mittelfristig/kurzfristig nutzbare Bauteile: 30/15/10 Jahre, Unterhaltung 1/2/3 %, Zinssatz 4 %, Versicherungsansatz 0,2 %
Depreciation for long term/medium term/short term lifetime building components 30/15/10 years, maintenance 1/2/3 %, interest 4 %, insurance 0.2 %.⁵⁾ Lohnansatz 15 €/AKh/Labour costs: 15 €/hour. ⁶⁾ Beschäftigungsautomat 20 g/(Tier · Tag)/Play automatic 20 g/(animal · day).⁷⁾ Stall und Auslauf 0,7 kg/(Tier · Tag)/Housing and outrun 0.7 kg/(animal · day).⁸⁾ Preise je t Stroh: Einstiegsstandard 130 € (Häckselsel), Premiumstandard 125 €, Ökologische Erzeugung 135 €/Price per t straw: entry standard 130 € (chaff), premium standard 125 €, organic production 135 €.

cluded. All prices are taken from the KTBL databank at the date 12th July, 2013 and shown without value added tax. Quantitative and procedural values are oriented on the KTBL data collection “Farm business planning 2012/13” [8] and “Organic farming” [9]. For evaluating the level of animal welfare the National Evaluation for Animal Production Systems was applied [10]. The evaluation system differentiates between animal health and animal behaviour, enabling a three-stage assessment of animal behaviour (A, B, C) as well as a two-stage assessment of animal health (R-, R+).

Costing results

The production under each of the four models differed mainly regarding costs for buildings, labour, straw and machinery application (Table 2). The annual housing costs lay between 37 and 52 € per animal place and year. The working time requirement fluctuated between 0.76 and 2.27 man hours per animal place and year, representing 11 to 34 € per animal place and year. Into the littered systems came costs for straw and machinery for litter spreading, dung removal and the supply of forage feed totalling a good 42 to 53 € per animal place and year. The costs for the additional housing equipment for the models “entry standard” are calculated in Table 3. For the rubber mats, which were fixed to the slatted flooring, annual costs because of the high investment and increased labour in keeping them clean came to over 10 € per animal place. The calcu-

lated eight year lifetime for the pilot housing has still to prove itself. The activity automatic, comprising straw rack with collection trough, the chains and soft wood, all required a roughly equal proportioning of costs for investment as well as for filling the rack with chopped straw. Pen cleaning input depended on whether the design permitted a partition between lying and dunging area. The costs for this varied greatly, especially for re-structured buildings and depended on the respective layout. In the pilot housing the favoured pens – and the ones assumed in the model – remained longitudinal with structured separation walls. Costs for a high-pressure spray cooling system were 2 € per animal place and year.

Individual costs of the four models are presented in Table 4.

The extra costs per piglet under the animal welfare label were put at 5 €, the GM-free feed required in the “premium standard” model added 8 € per feeding pig. The individual costs increase starting with the “conventional” model over the models “entry standard” and “premium standard” through to the model “production according to the EU organic farming directive” from 1.65 to 3.30 € per kg slaughter weight. Also for the higher welfare requirements, the main cost blocks were for the piglet and the feed at 75 to 80 % (Figure 1).

Results: level of animal welfare

Measured on the National Evaluation for Animal Production Systems, the results for the models “conventional” and “entry

Table 3

Cost of additional housing equipment for animal welfare label (entry standard)

Stalltechnik Equipment	Einheit Unit	Gummiliegematte Rubberised laying mat	Sprühkühlung Spray cooling	Beschäftigungsautomat Play automatic	Strukturierung Bucht Structuring of pen
Investition mit Montage Investment with assembly	€/TP	54 ¹⁾	10	15,3 ²⁾	30
Jahreskosten mit Zins Annual costs with interest	€/(TP · a)	7,83 ³⁾	1,45 ³⁾	2,22 ³⁾	3,60 ⁴⁾
Material (Wartung, Stroh) Material (maintenance, straw)	€/(TP · a)	-	0,24 ⁵⁾	0,81 ⁶⁾	-
Arbeit (Handhabung, Wartung) Labour (operation, main tenance)	AKmin/(TP · a)	10,84 ⁷⁾	0,49 ⁸⁾	5,07 ⁹⁾	-
Jahreskosten Annual costs	€/(TP · a)	2,71	0,12	1,27	-
Summe Jahreskosten Total of annual costs	€/(TP · a)	10,54	2,08 ¹⁰⁾	4,29	3,60

TP = Tierplatz/Animal place

¹⁾ 90 €/m², 0,6 m²/TP.

²⁾ 305 € für 20 Tiere / 305 € for 20 head.

³⁾ Nutzungsdauer 8 Jahre/Working lifetime 8 years.

⁴⁾ Nutzungsdauer 10 Jahre/Working lifetime 10 years.

⁵⁾ Jährlicher Filterwechsel (54 €), Pumpe Öl (20 €), 10 % der Düsen (9 x 17 €)/Annual filter change (54 €), pump oil (20 €), 10% of jets(9 x 17 €).

⁶⁾ 20 g/(Tier · Tag), 0,13 €/kg Kurzstroh/20 g/(animal · day), 0.13 €/kg chopped straw.

⁷⁾ Verschmutzter Liegebereich reinigen 2 min/Bucht, alle 2 Tage/Cleaning dirtied laying areas 2 min/pen every 2 days.

⁸⁾ Filterwechsel 30 min, Öl 20 min, Spülen und Testen (20 min/Abteil, 2 x jährlich), Düsen reinigen/wechseln (3 min/Düse) /Change filter 30 min, oil 20 min, flushing and testing (20 min/pen, twice annually), spray nozzles cleaning/replacing (3 min/nozzle).

⁹⁾ 1 min/Befüllvorgang, alle 5 Tage/1 min/filling, every 5 days.

¹⁰⁾ Incl. Wasser 0,14 €/(TP · a) und Energie 0,13 €/(TP · a)/Including water 0.14 €/(TP · a) and energy 0.13 €/(TP · a).

Table 4

Composition of direct costs per animal and per kg slaughter weight

Merkmal/Attribute	Konventionell Conventional	Tierschutzlabel/Animal welfare label		Erzeugung nach EG- Öko-Verordnung Organic farming
		Einstiegsstandard Entry standard	Premiumstandard Premium standard	
Einzelkosten [€/Tier]/Direct costs [€/animal]				
Ferkel/Piglet	52,79	57,80 ¹⁾	57,80 ¹⁾	111,52
Futter/Feed	75,19	75,19	83,31 ²⁾	140,76
Arbeit/Labour ³⁾	4,03	6,12	9,69	13,25
Gebäude/Building	12,94	23,70	16,04	19,05
Energie (Heizung, Strom)/Energy (heating, current) ⁴⁾	3,10	3,23	0,21	0,21
Wasser/Water ⁵⁾	1,47	1,52	1,62	1,71
Stroh/Straw ⁶⁾	-	0,29	11,07	11,95
Maschinen/Machinery	0,07	0,07	5,53	8,51
Sonstige Direktkosten/Other direct costs ⁷⁾	4,27	4,35	4,54	5,63
Summe absolut/Sum total	154	172	191	313
Einzelkosten [€/kg Schlachtgewicht]/Direct costs [€/kg slaughter weight]				
Summe Einzelkosten/Total direct costs	1,65 ⁸⁾	1,85 ⁸⁾	2,00 ⁹⁾	3,30 ⁹⁾
Mehrkosten zu konventionell Additional costs compared to conventional	-	0,20	0,35	1,65

TP = Tierplatz/Animal place

¹⁾ 5 €/Ferkel Zusatzkosten für Kastration mit Betäubung und pauschal höhere Anforderungen der Ferkelerzeugung/5 €/piglet additional costs for castration with anesthetic and general figure for higher requirements in piglet rearing.

²⁾ 0,03 €/kg zusätzlich für GVO-freies Futter/0.03 €/kg additionally for GM-free feed.

³⁾ 15 €/AKh/15 €/h.

⁴⁾ 0,25 €/kWh/0.25 €/kWh.

⁵⁾ 2 €/m³ Wasser/2 €/m³ water.

⁶⁾ Preise je t Stroh: Einstiegsstandard 130 € (Häcksell); Premiumstandard 125 €, Ökologische Erzeugung 135 €/Price t straw entry standard 130 € (chaff), premium standard 125 €, organic production 135 €.

⁷⁾ Sonstige Direktkosten: Tierarzt, Medikamente, Tierseuchenkasse, Viehversicherung, Ertragsschadensversicherung, Kadaverbeseitigung, Desinfektions- und Reinigungsmittel, Zinskosten Umlaufvermögen/Other direct costs: vet, medicine, epidemic fund, animal insurance, yield compensation insurance, carcass removal service, disinfectant and cleaning materials, interest, capital in current assets.

⁸⁾ 256 kg Schlachtgewicht/(TP · a), 2,83 Umtriebe/a, 118 kg Endgewicht/256 kg slaughter weight/(TP · a), 2.83 cycles/a, 118 kg end weight.

⁹⁾ 236,4 kg Schlachtgewicht/(TP · a), 2,57 Umtriebe/a, 120 kg Endgewicht/236.4 kg slaughter weight/(TP · a), 2.57 cycles/a, 120 kg end weight.

standard” are the same (Table 5). This also applies to the results of comparison between the models “premium standard” and “production according to EU organic farming directive”. The results in Table 6 show that in the models “premium standard” and “production according to the EU organic farming directive” the majority of natural behavioural traits are able to be carried out without hindrance. In the case of the model “conventional” most of the behavioural indicators are strongly limited or unable to be carried out at all. The model “entry standard” gave results that lie between both these blocks.

Discussion of results

Costs

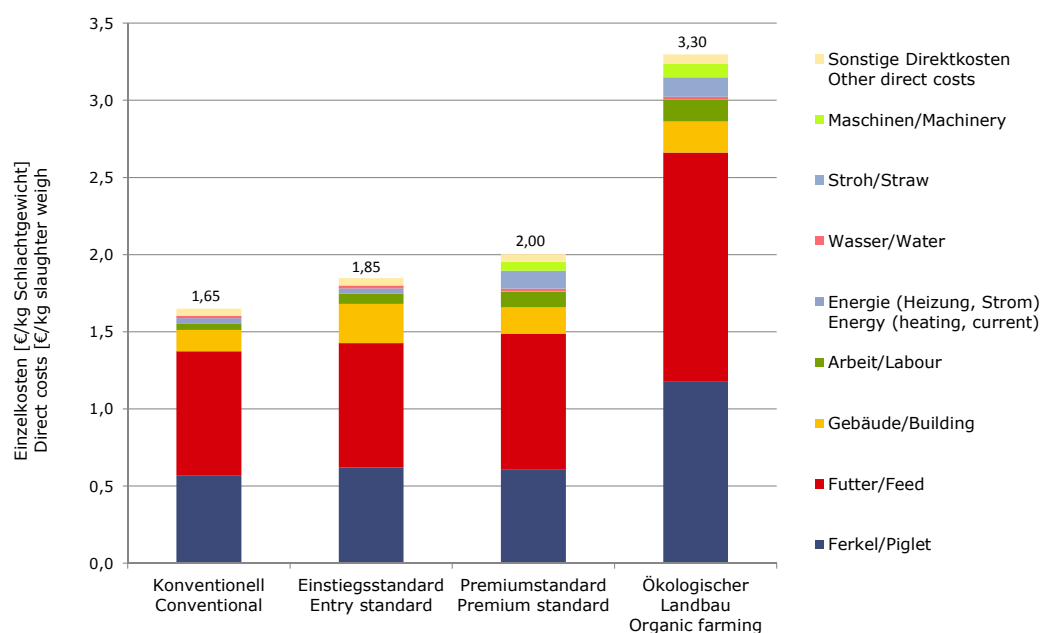
The production costs for pig meat produced according to the criteria of the animal welfare label were, according to model calculations, 20 to 35 cents per kg slaughterweight or 12 to 23 % over the ware produced according to conventional standards; at the same time these costs represented only 60 % of those for the organic ware. The label “for more animal welfare” is thus suitable

for the production of medium-priced products and can fill the gap existing until now between conventional and organic ware.

The models confirm that the labour requirement for the animal welfare label (depending on standard) lies 50 to 140 % over that of the conventional model. The labour requirement increased, while still remaining reasonable, with the model “entry standard”, particularly through the additional cleaning of the lying areas and the filling of the activity equipment. The model “premium standard” demanded, on the other hand, considerable more labour for litter spreading and dung removal. The costs of the organic model were significantly over those of the comparative models especially regarding costs for the piglet, feed and labour.

The costs for the housing with both models “premium standard” and “production according to the EU organic farming directive” lie 24 and 47 % over the conventional model. The costs for the larger space involved were largely reduced due to the simpler design of the building as fresh air housing with outdoor run and no liquid manure channel.

Abb. 1



Comparison of direct costs per kg slaughter weight in different production systems

The building for the model “entry standard” was exceptional within the series with 83 % additional costs. Responsible for this were the closed building design with forced ventilation plus more floor space per animal and the additional interior equipment. Fresh air housing is basically suitable for the entry standard, possible costs for a mobile dung removal system have to be considered here as well. For this reason the entry standard tends to be more suitable where modification can be carried out on buildings.

Cost savings through economies of scale featuring increasing livestock numbers can reach 12 % in conventional animal housing [8]. Those supplying the premium standard are allowed a maximum 950 feeding pig places. When compared with other standards a marketing disadvantage can occur here in that such a digression effect cannot be employed.

Animal behaviour and animal health

In the “conventional” and “entry standard” models normal behaviour of the animals was severely limited. Additionally, animal health risks are hardly controllable, or controllable only with considerable input. Improvements can, however, be achieved as shown by detailed observation of animal behaviour. In comparison with the “conventional” model, nine behavioural indicators were assessed as better. In sum, these improvements were not sufficient for the better behavioural category “B”.

The situation is different with the models “premium standard” and “production according to the the EU organic farming directive”. With both, there appear no limits to natural behaviour and the animal health risks are able to be well controlled through management. The detailed assessment of animal behaviour showed very little difference between the

Table 5

Assessment of animal behavior and animal health with the “National Evaluation for Animal Housing Systems”

Merkmal/Attribute	Konventionell Conventional	Tierschutzlabel/Animal welfare label		Erzeugung nach EG-Öko-Verordnung Organic farming
		Einstiegsstandard Entry standard	Premiumstandard Premium standard	
Tierverhalten/Animal behavior	C	C	B	B
Tiergesundheit/Animal health	R+	R+	R-	R-

A = Das Normalverhalten ist weitgehend ausführbar / Normal behavior is extensively achievable.

B = Das Normalverhalten ist eingeschränkt ausführbar / Normal behavior is restricted.

C = Das Normalverhalten ist stark eingeschränkt ausführbar / Normal behavior is strongly restricted.

R- = Risiken für die Tiergesundheit lassen sich durch Management gut beherrschen / Animal health risks can be controlled with normal management input.

R+ = Risiken für die Tiergesundheit lassen sich kaum oder mit erheblichem Aufwand beherrschen / Animal health risks can only be controlled with high management input.

Table 6

Assessment of animal behavior with the National Evaluation for Animal Housing Systems

Funktionskreis/Indikator <i>Functional circuit/indicator</i>	Konventionell <i>Conventional</i>	Tierschutzlabel/ <i>Animal welfare label</i> Einstiegsstandard <i>Entry standard</i>	Premiumstandard <i>Premium standard</i>	Erzeugung nach EG-Öko-Verordnung <i>Organic farming</i>
Sozialverhalten/Social behavior				
Gruppe/ <i>Group</i>	u. a.	u. a.	u. a.	u. a.
Sozialstruktur/ <i>Social structure</i>	u. a.	u. a.	u. a.	u. a.
Sozialkontakt/ <i>Social contact</i>	u. a.	u. a.	u. a.	u. a.
Ausweichen und sich zurückziehen/ <i>Avoidance and retreat</i>	n. a.	e. a.	u. a.	u. a.
Fortbewegung/Locomotion				
Gehen/ <i>Move</i>	u. a.	u. a.	u. a.	u. a.
Laufen/ <i>Move fast</i>	n. a.	n. a.	u. a.	u. a.
Rennen/ <i>Running</i>	n. a.	n. a.	n. a.	e. a.
Drehung/ <i>Rotation</i>	u. a.	u. a.	u. a.	u. a.
Ruhen und Schlafen/Resting and sleeping				
Abliegen/ <i>Laying down</i>	e. a.	e. a.	u. a.	u. a.
Aufstehen/ <i>Standing up</i>	u. a.	u. a.	u. a.	u. a.
Ruhe- und Schlafplatzwahl/ <i>Resting and sleeping place selection</i>	n. a.	e. a.	e. a.	e. a.
Ruhe- und Schlaflage/ <i>Resting and sleeping position</i>	e. a.	u. a.	u. a.	u. a.
Störungsfreies Ruhen und Schlafen/ <i>Undisturbed rest and sleep</i>	n. a.	e. a.	u. a.	u. a.
Nahrungsaufnahme/Feed intake				
Nahrungssuche/ <i>Foraging</i>	n. a.	e. a.	e. a.	u. a.
Futteraufnahme/ <i>Feed intake</i>	u. a.	u. a.	u. a.	u. a.
Wasseraufnahme/ <i>Water intake</i>	e. a.	e. a.	u. a.	u. a.
Ungestörte Futteraufnahme/ <i>Undisturbed feed intake</i>	n. a.	n. a.	e. a.	e. a.
Futterbearbeitung/ <i>Food processing</i>	n. a.	e. a.	e. a.	u. a.
Objekt orientierte Beschäftigung und Spielen <i>Object oriented occupation</i>	e. a.	u. a.	u. a.	u. a.
Ausscheidung/Excretion				
Koten und Harnen/ <i>Defecating and urinating</i>	n. a.	u. a.	u. a.	u. a.
Komfort/Comfort				
Eigene Körperpflege/ <i>Personal hygiene</i>	u. a.	u. a.	u. a.	u. a.
Körperpflege am Objekt/ <i>Bodycare on object</i>	n. a.	e. a.	u. a.	u. a.
Thermoregulatorisches Verhalten (Vermeidung Wärmeverlust) <i>Avoiding heat loss</i>	n. a.	n. a.	e. a.	e. a.
Thermoregulatorisches Verhalten (Abkühlung)/ <i>Cooling behavior</i>	n. a.	n. a.	e. a.	e. a.
Erkundung/Exploration				
Räumliche Erkundung/ <i>Spatial exploration</i>	n. a.	n. a.	u. a.	u. a.

u. a. = Das Normalverhalten ist uneingeschränkt ausführbar/*Normal behavior is always possible.*e. a. = Das Normalverhalten ist eingeschränkt ausführbar/*Normal behavior with restrictions.*n. a. = Das Normalverhalten ist stark eingeschränkt/nicht ausführbar/*Normal behavior is strongly restrictedly/not able to be carried out.*

models “premium standard” and “production according to the EU organic farming directive”. In animal welfare terms this indicates a better cost benefit ratio for the model “premium standard”. For the evaluation of animal behaviour under category “A” no behavioural indicator “strongly limited/not limited” is possible. A maximum of three may be termed “limited”. Both models offer instead the requirement when a separate

lying bay, a shower or a loafing area as well as a protected feeding area are offered.

Assessment of animal welfare standard based on resources is controversial in the public domain, spoken of as “animal welfare by yard stick”. The application of the National Evaluation for Animal Production Systems with the four models underlined these problems. Because of the 1.1 m² space availabil-

ity, two indicators had to be marked down a stage because the evaluation limit was $\leq 1, 1 \text{ m}^2$. The influence on the total results of the four models was, however, not significant.

Conclusions

Applying the National Evaluation for Animal Production Systems shows a significantly higher animal welfare standard is achievable over the model "conventional". This is especially so with the models "entry standard" and "production according to the EU organic farming directive", even if none of the models actually achieved the best of the three evaluation categories "A" for expression of natural animal behaviour.

If a pig feeder aims for an especially high animal welfare standard he or she should, therefore, not depend on following the minimum standards alone. An analysis of the effects of animal welfare should be an important part of housing planning. The calculations indicate extra costs for label ware of 20 to 35 c/kg meat compared with ware from conventional production. The costs for production of meat in the model "premium standard" are a good bit higher than those for in the model "entry standard". Against this, however, the former offers the best cost-benefit ratio in terms of resource-based animal welfare. Contrary to the case with the animal welfare label, costs in organic agriculture cannot be attributed to animal welfare alone: environmental protection, social economics represent further requirements reflected in the extra costs.

The models observed here show improvement possibilities. These are confirmed by the DAFA approach to research [11] which notes a requirement in research towards the improvement of the existing situations and encourages the development of alternative, fundamentally different, production methods.

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