

Economic, ecological, and social performance of conventional and organic broiler production in the Netherlands

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Economic, ecological, and social performance of conventional and organic broiler production in the Netherlands

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15	Abstract		
16 I	1 In this study, we compared a conventional broiler production system keeping fast	Formatted: Tabs: 14.2 pt, List tab + Not at 28.35 pt	
		Deleted: equivalent for	
17	growing broilers with an organic broiler production system keeping slow growing	Deleted: societal issues in the Netherlands	
18	broilers in the Netherlands, both managed by one person working a full time year (Full	Deleted: based on	
19	Time Equivalent, FTE). This comparison was based on a quantification of economic.	Deleted: slow growing broiler production	
20	$\frac{1}{2}$	Deleted: issues	
20		Deleted: more ammonia	
21	national data sets.	Deleted: and,	
22	2. The organic system performed better for the economic indicator net farm income per $\int_{0}^{0} \frac{d^{2}}{dt_{1}}$	Deleted: , potentially more eutrophication	
		Deleted: the slow growing broiler	
23	FTE than the conventional system.	Deleted: system. Total fossil energy use is expected to be higher per bird	
24	3. Regarding ecological indicators, calculations showed a higher on-farm emission of $\int \int \int$	in slow growing broilers because most fossil energy is used to produce feed	
25	ammonia per kg live weight for the organic system. Moreover, an organic system	Deleted: slow growing broilers are	
26	includes a higher risk for eutrophication per ha, due to outdoor access. Emission of	less efficient in converting feed than fast growing broilers. The latter is also a reason for higher land	
27	green house gasses, use of fossil fuels and use of land required for the production of	Deleted: in organic broiler production, besides the fact that crop harvest per hectare is lower in	
28	one kg of live weight is higher for an organic than for a conventional system. This is \int_{U}^{U}	general in	
29	mainly due to a lower feed conversion in organic production and use of organic feed	Deleted: production.	
20		production	
30	4. The organic system performed better than the conventional system for the social	Deleted: all	
31	indicators related to animal welfare time spent on walking, footpad lesions, mortality,	Deleted: the societal issue	
_		Deleted: foot	
32	and sound legs. Regarding the social indicator, food safety was found that meat from an	Deleted: another societal issue	
33	organic system contained less antibiotic residues and Salmonella contaminations but	Deleted: ,	
34	more Campylobacter contaminations than meat from a conventional system.	Deleted: the slow growing production system appeared to contain	
35	5. Changing from a conventional to an organic broiler production system, therefore, not	Formatted [1]	
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36	only affects animal welfare, but also affects economic, ecological and other social	Deleted: a slow growing	
37	issues. In this study, we ran into the situation that some information needed was	Deleted: has much more [2]	
38	lacking in literature and quantifications had to be based upon several sources.	Deleted: . Although it is difficu [3]	
00	Therefore an intermeted on from exercise and the little of	Deleted: the contribution to [[4]	
39	interetore, art integrated on-tarm assessment is needed, which can be used to develop	Deleted:	
40	a broiler production system that is economically profitable, ecologically sound, and	Deleted: for that. In this way (
44	appartable for appiety	Deleted: developed	
41	acceptable for Society _z	Deleted: , economic profitable [7]	

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1			,	Formatted: Font: 11 pt, Check
2	42	5. INTRODUCTION	1	spelling and grammar
3 4			1	Deleted: a
5	43	Selective breeding for high growth rate and low feed conversion in broilers has been	2	Deleted: a
6	44	succesful, but selection impairs animal welfare due to health problems and behavioural		Deleted: very
7	45	changes (Savary, 2002; Polykers and Kaona, 2002; Turner et al. 2002). A modern		Deleted: appears to be associated with impaired
0 9	40	changes Savory, 2002, Donners and Roene, 2003, runner et al., 2003). A modern	~	Formatted: Font: Italic
10	46	broiler grows on average from 40 g to 2100 g in about 6 weeks. This high growth rate is		Field Code Changed
11 12	47	different for, different body parts, (Nestor, et al., 1985; Havenstein, et al., 2003), which	/	Deleted: appears to be unbalanced over
13 14	48	creates skeletal-biomechanical imbalances (Lilburn, 1994; Corr. et al., 2003a, 2003b)	N 11 11	contribution of the breast muscle to total body weight has increased
15	49	and increases susceptibility to metabolic disorders (Scheele, 1996; Gonzales et al.,		Formatted: Font: Italic
16	50	1999: Havenstein at $a(-2003)$		Formatted: Font: Italic
1/	50			Formatted: Font: Italic
19	51	Time spent on different behaviours has changed in fast growing broilers		Deleted: . This unbalanced growth is shown also for organs essential for
20 21	52	compared with other lines (Bokkers et al., 2000; Bokkers and Koene, 2003), while the		metabolism. Lung and heart weight as percentage of body weight were lower in fast growing broilers than in
22	53	normal behavioural repertoire of a chicken has maintained. Incidence of several	<u>}, </u>	random bred chickens
23	54	behaviour patterns decreases with increasing age and body weight. In addition, many	1,1	Field Code Changed
24 25	01	Sondwoor patterne desreaded within eacing age and body weight. In addition, many	11 \	Deleted: . As a result of unbalanced
26	55	behaviour patterns are performed increasingly in a sitting posture instead of a standing	n N	growth, and associated altered metabolism, fast growing broilers
27 28	56	posture with increasing age (Weeks et al., 1994; Reiter and Kutritz, 2001; Bokkers and		show increased susceptibility to metabolic disorders such as sudden death syndrome and ascites
29	57	Koene, 2003) <u>.</u>		Field Code Changed
30 31	58	Fast growing broilers are the most common lines kept for chicken meat		Deleted: (Scheele, 1996; Gonzales et al., 1999)
32	59	production. There are, however, slow growing lines that are also kept for chicken meat	111 111	Deleted: .¶ Regarding behaviour of fast growing
33 34 35	60	production. Roughly, there are two types of slow growing broilers: "medium" and		broilers was found that not the behavioural repertoire, but time spent on different behaviours has changed
36	61	"normal" Medium-slow growers grow to a slaughter weight of 2100 g in about 8 weeks	111 111	Field Code Changed
37	01		11 11	Deleted: Bokkers
38	62	whereas normal slow growers need 12 weeks to reach the same slaughter weight.	1	Formatted: Font: Italic
39 40	63	Because of their lower growth rate, slow growing broilers are presumed to have fewer		Deleted: 2000
41	64	health and physical problems then fact around a brailers. In the Netherlands, along		
42	64	nearth and physical problems than last growing broners. In the Nethenands, slow		
43 44	65	growing broilers are kept mainly for organic chicken meat production. In organic broiler		
45	66	production, birds are kept at a lower stocking density than in conventional broiler	,	Deleted: . Several behaviour
46 47	67	production. Stocking density is seen, in addition to high growth rate of the used lines,	/	patterns decrease with increasing age and body weight and many behaviour patterns are performed in a sitting
48 49	68	as one of the factors for welfare problems in conventional broiler production (EU, 2000;		posture in stead of standing posture to an increasing extent when getting older
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69	Hall, 2001), A high stocking density reduces freedom of movement, and affects litter		
70	and air quality negatively (Bessei, 2006)		
71	A decision to introduce an organic broiler production system that includes		
72	keeping slow growing broilers at a low stocking density is expected to affect the welfare		
73	status positively. Such a decision in favour of welfare, however, also has economic,		
74	ecological, and other social consequences, as shown, e.g., in egg production systems		
75	(Mollenhorst et al, 2006). Organic regulations, for example, determine that animals		
76	should have outdoor access for a certain period of their life or of the year. In addition to		
77	improved animal welfare, such regulations may have negative environmental		
78	consequences, such as, higher ammonia volatilisation or nitrogen leaching		
79	(Hermansen et al., 2004), Making a well-reasoned, holistic consideration		
80	whether one production system contributes more to sustainable development than		
81	another, therefore, requires comparison of the economic, ecological, and social		
82	performance of both production systems. In our case, the contribution to sustainable		
83	development of a conventional broiler production system and an organic broiler		
84	production system should be assessed. In this study, we compared the combined		
85	economic, ecological, and social performance of a defined conventional broiler		
86	production system with a defined organic broiler production system.		
07	METHODOLOGY		
87	METHODOLOGY		
88	The four step methodology used in this study was based on ideas of Bell and Morse		
89	(1999) and was developed further by Mollenhorst and De Boer (1999). This		
90	methodology has been used to evaluate the economic, ecological, and social (EES)		
91	performance of different egg production systems (Mollenhorst et al., 2006) and seems		
92	suitable to evaluate the EES performance of broiler production systems. The		
93	methodology consists of four steps: 1) description of the problem situation and		
94	definition of the systems, 2) identification of relevant economic, ecological, and social		

Deleted: (Weeks et al., 1994; Reiter and Kutritz, 2001; Bokkers and Koene, 2003)

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Fast growing broilers are the most common genotypes that are kept for poultry meat production. There are, however, broilers selected especially to grow slower. Slow growing broilers are presumed to have less health and physical problems than fast growing broilers. Roughly, there are two types of slow growing broilers. Medium slow growers grow to slaughter weight in about 8 weeks while "normal" slow growers grow to slaughter weight in 12 weeks. In the Netherlands, slow growing broilers are kept mainly for organic poultry meat production. In organic broiler production birds are kept at a much lower stocking density than in conventional broiler production. Stocking density is seen as an important cause of welfare problems in conventional broiler production, besides the unilateral genetic selection

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Deleted: . ¶ A decision to introduce slow growing broilers in a production system and keeping them at a low stocking density is expected to affect the welfare status positively. Such a measure in favour of welfare, however, also has economic, ecological and other societal consequences as shown by Mollenhorst et al.

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Deleted: in egg production systems. Organic regulations, for example determine that animals should [... [8] **Field Code Changed** Deleted: (Hermansen et al., 2004) Deleted: . Making a well reasoned holistic consideration whether one production system contributes [... [9] Field Code Changed Deleted: (2004) Deleted: and has been further developed by Mollenhorst and De Boer **Field Code Changed**

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1 2	95	issues (3) selection and quantification of indicators for each issue, and (4) final	
3 4	96	assessment of the contribution of production systems to sustainable development.	Deleted: . This methodology has been conducted for different egg production systems
с С			Field Code Changed
7	97	Step (1): Description of the problem situation and defining the systems	Deleted: , 2005)
8 9	98	The first step requires a description of the problem situation and definition of the	Formatted: Check spelling and
10 11	99	systems. The problem situation was described in the introduction. The systems were a	Deleted: and seems to be useful to apply for other production systems as well It consists of the following steps:
12	100	defined conventional broiler production system and a defined organic broiler production	1) description of the problem situation and of the system in study, 2) identification and definition of relevant
13	101	system, each managed by one person working a full-time year (Full Time Equivalent,	economic, ecological en societal issues, 3) selection and quantification
15 16	102	FTE). Both systems were characterised by production, housing, and management, with	final assessment of the contribution to sustainable development. These four
17 18 10	103	related inputs and outputs (see below the section on definition of production systems).	steps are described in more detail. ¶ Step (1): Description of the problem situation and the system in study¶ The first step requires a description of
19 20	104	Step (2): Identification and definition of economic, ecological and social issues	the problem situation and of the systems in study. The problem situation is described in the
21 22	105	The second step implies the selection of EES issues relevant for sustainable	introduction. The systems in study are a defined conventional broiler production system with fast gr
23 24	106	development of a broiler production system. Based on recent assessment studies	Deleted: ,
25	107	(Mollenhorst and de Boer, 2004; van Calker et al., 2004), we selected nine EES issues:	Deleted: energy use
26	108	profitability of the farm, acidification of the soil, eutrophication of terrestrial and aquatic \int_{u}^{u}	Formatted: English (U.S.)
28			Formatted: English (U.S.)
29	109	ecosystems, use of fossil fuels, land use, animal welfare (including animal health), food _/	Formatted: English (U.S.)
30	110	safety, product quality and working conditions. These nine EES issues will be	Deleted: actual
31			Formatted: English (U.S.)
32	111	discussed in this study.	Deleted: used
33			Formatted: English (U.S.)
34 25	112	Step (3): Selection and quantification of indicators	Deleted: the following five
36			Formatted: English (U.S.)
37	113	The third step involves the selection and quantification of indicators for the selected	Formatted: Dutch (Netherlands)
38	111	EES issues. An indicator, which is a parameter that quantifies the status of an issue is $\int \frac{d^2 h_{ij}}{dt_{ij}}$	/ Field Code Changed
39	114		Formatted: English (U.S.)
40	115	needed for each EES issue. For the comparison of production systems, we selected	Formatted: English (U.S.)
41			Deleted: fast growing broilers in a
42	116	the best available indicators using six criteria: relevance, simplicity, sensitivity, $\int_{0}^{\infty} \int_{0}^{1} \int_{0}^{1$	Formatted: English (U.S.)
43	117	reliability trend/target accessibility of data (Mitchell et al. 1995; de Boer and $\frac{\int_{0}^{1} \frac{dy}{dy}}{\int_{0}^{1} \frac{dy}{dy}}$	Deleted: production system
44	117		Formatted: English (U.S.)
45	118	Cornelissen, 2002; Mollenhorst et al., 2006). The selected indicators for the	Deleted: slow growing broilers in an
46			Formatted: English (U.S.)
4/	119	comparison of the conventional and the organic broiler production system were	Formatted: English (U.S.)
48	120	quantified based on scientific literature and data bases of Dutch institutes: the	Deleted: , national
49 50	120		Formatted: English (U.S.)
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Agricultural Economic Research Institute, the Ministry of Agriculture, Nature and Food
Quality, the Product Boards of Livestock, Meat and Eggs, and Statistics Netherlands.
For social issues, we selected comparative studies for conventional and organic
broiler production. In some cases, however, studies were used that compared fast and
slow growing broilers where the slow growing broilers were not kept within the organic
constraints. For economic and ecological performance, we used average values from
handbooks for animal production (KWIN, 2003-2004, 2006) and data from literature to
derive, new computations for the indicators. Selection and quantification of indicators is
described for each issue (see below).
Step (4):_Final assessment of the contribution to sustainable development
In the fourth step, information from all indicators is combined to determine the final

outcome of the contribution of the system to sustainable development. This step is

ECONOMIC PERFORMANCE

considered in the general discussion section.

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Net farm income is the best indicator for economic performance of a farm (van Calker	-	Deleted: RESULTS AND DISCUSSION¶ Economic issues¶
et al., 2005). Net farm income is defined as the difference between revenues and		Deleted: system
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costs, excluding costs of family labour (van den Tempel and Giesen, 1992). To	,	Formatted: Font: Italic
estimate economic performance, we must first describe the system and the year in		Deleted: must
	- /	Deleted: on
which the computations were based. A conventional broiler production system (further	-4	Deleted: are
called conventional system) was compared with an organic broiler production system		Deleted: system with fast growing broilers
(further called exercise system) both menored by one ETE is 0000. For this study, it	11.	Deleted: in this paragraph) is
turiner called organic system, both managed by one ricking 2003. For this study, it	N	Deleted: system with slow growing broilers
was assumed that both systems use an all-in all-out procedure to start and finish a	7 111	Deleted: in this paragraph
production round. An all-in all-out procedure means all birds within a production round		Deleted: fulltime equivalent (
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at a farm arrive and leave the farm at the same day.	$\frac{n_{II}}{n_{II}}$	Deleted: in the year
	$\frac{11}{11}$	Deleted: is presumed
Definition of the production systems	11	Deleted: production
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2 3	146	In the conventional system, one FTE can manage 70,000 birds (KWIN, 2003-2004).	Deleted: . Birds are kept with a
4	147	Stocking density is 22 birds per m ² . A production round takes 53 days (43 days growing	Deleted: of
5 6	148	birds, 10 days empty). which means about seven production, rounds per year (365/53).	Deleted: and a
7	149	Houses are lighted artificially and the climate is controlled with heaters and mechanical	Deleted: period
8	110		Deleted: 365/53 = 6.9
9 10	150	ventilation. Water is provided by drinking nipples and feed by automatically filled open	Deleted: The birds are housed under conditions of artificial light. Climate in the house is
11	151	feeders. The floor is covered with wood shavings (Rodenburg and van Harn, 2004).	Deleted: in
13	152	In the organic system, one FTE can manage a maximum of 16,000 birds, which	Deleted: it is allowed to keep
14	153	have to be kept in several houses. Stocking density is a maximum of 10 birds per m ²	
16 17	154	on a total useful floor area of 1,600 m ² ,(EU, 1999). The maximum number of birds per	Deleted: at maximum
18	155	house is 4,800 (EU, 1999). According to the Council Regulation 1804/1999, it is not	manage 16,000 birds that have to be kept in several houses.
20	156	allowed to slaughter organic broilers before 81 days of age, unless slow growing lines,	Deleted: genotypes
21	157	are used (EU, 1999). Because only slow growing lines are used in practice, organic	Deleted: In
22	158	broilers are slaughtered around 70 days of age, Organic broilers are kept in houses	Deleted: this means that Deleted: because the only used genotypes are slow growing
24 25	150	with natural ventilation and natural davlight, supplemented by artificial light (Rodenburg	genotypes
26	159		Deleted: and additional
27	160	and van Harn, 2004). In the beginning of the growing period, houses are heated	Deleted: the
28 29	161	according to a similar temperature schedule as used in a conventional system.	Deletedu Weter
30	162	Throughout the growing period, water, is provided in open drinkers and feed is available	
32	163	in open feeders that are filled by hand. The floor is covered with chopped straw	Deleted: which
33 34	164	(Rodenburg and van Harn, 2004). Feed for organic broilers must be GMO-free, and	Deleted:
35 36	165	finisher feed should contain at least 65% cereals. Furthermore, 85% of the dry matter	Deleted: the
37 38	166	of the feed must be of organic origin, and antimicrobial growth promoters and	
39	167	anticoccidials are not allowed. An overview of technical data for both systems that is	Deleted: of
40	100		Deleted: can be found
41 42	168	used for the economic computations <u>is</u> in <u>Iable 1</u> .	
43 44	169	INSERT TABLE 1	
45			Deleted: For the
46 47	170	Data and accumptions for economic calculations	Formatted: Font: Italic
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171	For the conventional system, calculation, of net farm income was based on intensive	- Formatted: Indent: First line: 0 pt - Deleted: a reference book full
172	animal production in the Netherlands (KWIN, 2003-2004: 2006), whereas for the	quantitative information
173	organic system calculation of net farm income was based on data of Vermeii (2004)	Deleted: was used as base for the conventional system and
174	(Table 2). Vermeij (2004) made several assumptions for the organic system because	Deleted: as base for the organic system
175	data were lacking. These assumptions are summarised, Water intake is related to feed	Deleted: broiler production because actual data did and do not exist
		- Deleted: relates
176	in a ration of 1.8:1. Water intake of a broiler was 7 I in 43 days, so water intake was	Deleted: as
177	assumed to be 11.5 I in 70 days. Costs for health care were expected to be higher for	Deleted: is
		Deleted: ,
178	an organic system than for a conventional system, because extra vaccinations are	Deleted: is
179	necessary due to outdoor access. Costs per bird for electricity were expected to be	(2004) costs
180	lower than in a conventional system due to natural ventilation and natural daylight, a	Deleted: broiler
		Deleted: are
181	Although a similar amount of energy is used in both systems to heat one m ³ of air,	Deleted: per bird
182	heating costs per bird were expected to be higher in an organic system than in a	Deleted: making use of day light. Heating costs are expected to be
183	conventional system. This difference was expected because in an organic system.	because a
184	fewer birds are kept per m ² , which makes it more expensive to heat the building when	Deleted: but in the production system with the slow growing broilers it is divided by
185	expressing the costs per bird. Costs per bird for bedding were higher in an organic than	Deleted: per square meter due to a lower stocking density. Costs for
186	in a conventional system, because more litter is used per square meter and birds are	Deleted: are
187	kept in a lower stocking density. Costs for catching and loading the birds for slaughter	Deleted: per bird in organic slow growing production
100	were higher for an errorie system due to smaller flecks. Costs for legal animal health	Deleted: are a little
100	were nigher for an organic system due to smaller nocks. Costs for legal animal realth	- Deleted: per bird
189	levies collection service for dead animals were similar for both systems. Manure	Deleted: the
100		Deleted: and carrion collecting
190	transport for the conventional system was based upon a farm with no land. Because	
191	there is a manure surplus in the Netherlands, the removal of manure from the farm	Deleted. production
192	involves costs. This situation is different for an organic system. There was enough	
100	demand for evening neultry menure that no posts for menure removal and transport	Deleted: No
193	demand for organic poulity manure that hd, costs for manure removal and transport	Deleted: were
194	needed to be taken into account.	- Deleted: for the organic system because there is enough demand for
195	INSERT TABLE 2	organic poultry manure to find a destination without costs
196	Final economic calculations	
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2	197	Final economic calculations are summarised in Table 3. Regarding the variable	
4	198	and fixed costs, some additional comments are needed. Feed costs were calculated	
5	199	according to the formula: EC x (BS \pm 0.5BD), whereas EC is feed consumption per bird	Deleted: based upon
6	100		Deleted: multiplied by the
7 8	200	BS is the number of birds that reached the slaughterhouse alive, and BD is the number	Deleted: plus
9	201	of birds that died during the production round. Feed consumption of BD is multiplied by	Deleted: feed consumption per bird multiplied by half
11	202	a half to estimate the amount of feed consumed by birds that died at different moments	Deleted: the
12 13	203	of the production round.	
14	204	For the conventional system, investment costs were estimated 180 ELIB per m^2	Deleted: period.
15	204		Deleted: fast growing broilers
16	205	for the building and 70 EUR per m ² for the inventory (KWIN, 2003-2004). For the	Deleted: are
17	206	erganic system investment costs were estimated 160 EUP per m^2 for the building and	Deleted: €
10	206	organic system, investment costs were estimated too EOR per in tor the building and	Deleted: Investment costs for
20	207	30 EUR per m ² for the inventory (Vermeij, 2004).	Deleted: are
21			Deleted: €
22	208	For the conventional system, depreciation, for the building was 3.5% and for the	Deleted: €
23	209	organic system, it was 3%. Maintenance costs for the building were 1% for both	Deleted: Depreciation
24			Deleted: for the conventional system
25	210	systems. Costs for depreciation (6.5%) and maintenance (2%) for the inventory were	Deleted: 3%
20 27	211	similar for both systems (KWIN, 2003-2004).	Deleted: and maintenance
28			Deleted: production
29	212	Investments for the outdoor run in the organic system were 37,400 EUR per ha.	Deleted: production
30	213	Costs for the outdoor run were based on interest (0.09 EUB per m^2) costs for fencing	Deleted: €
31	2.0		Deleted: €
32	214	and furniture (0.025 <u>EUR per m²)</u> , and maintenance (0.02 <u>EUR per m²)</u> (Vermeij,	Deleted: /
33	215	2004) Organic production has to answer to special regulations that are controlled by	Deleted: /
34	215	2004). Organic production has to answer to special regulations <u>mat</u> are controlled by	Deleted: €
36	216	the independent organisation "Skal" in the Netherlands. Levies for Skal were based on	Deleted: /
37	017	an appual fee of 260 EUR and an additional 0.05 EUR par hird (Skal. 2004). Finally	Deleted: which
38	217		Deleted: upon a yearly
39	218	costs for accounting, insurances, telephone, clothing, contributions, etc, were, expected	Deleted: €
40	010		Deleted: €
41 12	219	to be similar for both systems.	Deleted: are
42			Deleted: production
44	220	INSERT TABLE 3	
45			
46			
47	221	Discussion on the economic calculations	
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49 50			
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222	Although price per kg of meat was lower for the conventional system than for the	
223	organic system, total revenues were higher because of more birds per production	
224	round (70,000 vs 16,000) and more production rounds per year (6.9 vs 4.6). More birds	
225	and production rounds, however, also meant more total costs (689 vs 265 kEUR). The	
226	main contributors to the higher costs, in the conventional system were feed (399 vs 165	Deleted: As shown
227	<u>kEUR) depreciation (45 vs 14 kEUR), and manure transport (12 vs 0 kEUR). As a</u>	
228	result, net farm income was higher in the organic system (73 kEUR) than in the	Deleted: table 3,
229	conventional system (7 kEUR). Economic results, however, depend heavily on market	
230	prices and feed costs. In the future, for example, when the consumer market for	
231	organic broiler meat increases, production will increase as well. The whole production	
232	chain will get more professional and therefore more efficient. Consequently, prices and	
233	costs will decrease. It is difficult to predict whether an organic broiler farmer can make	
234	a profit in that case.	
235	Economic calculations were based on several assumptions. One assumption	Deleted: production system. Calculations are
236	was that all parts of the organic birds were sold as organic meat. In reality, however, it	Deleted: important
237	is hard to sell all parts as organic meat, especially in the Netherlands, where many	Deleted: of these birds
238	consumers huw only specific fresh chicken parts, such as breasts and leas instead of a	Deleted: . Especially
200	whole shicken. The market for other freeh shicken parts is verifield in the Netherlands	
239	whole chicken. The market for other resh chicken parts is variable in the Nethenands.	
240	Unsold parts will be processed by the food industry or exported, in many cases as	Deleted: the
241	conventional meat, which reduces profits for the farmer. Furthermore, the market for	Deleted: to conventional chicken
242	organic products is small. High prices for organic meat compared with conventional	Deleted: are manificated in relation
243	meat and limited availability in supermarkets account for the limited demand by	Deleted: are mentioned in relation
244	consumers for organic products (Tacken <i>et al.</i> , 2007).	Deleted: of
0.45		Formatted: Font: Italic
245	In addition, the farm size for the organic system is large compared with the	Deleted: assumed
246	average farm size, which is around 3,200 birds per farm. Consequently, most farmers	Deleted: assumed
247	with an organic system need to have a second source of income. The low net farm	Deleted: broiler production
		Deleted: in reality
248	income of the conventional system corresponded to reality, because conventional	Deleted: organic broiler
		Deleted: Conventional

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		Deleted: meat
249	broiler production has not been very profitable in the Netherlands recent years (Bolhuis	Deleted: last
250	and Wisman, 2007).	Deleted: Our results found for economic performance correspond, therefore, to reality.
251	ECOLOGICAL PERFORMANCE	
252	The environmental performance of a broiler production system can be quantified by	Deleted: Ecological issues¶
253	assessing the impact of that system on acidification of the soil, eutrophication of	
254	terrestrial and aquatic ecosystems, and on climate change, and by measuring, its use of	Deleted: , global warming and to determine
255	land, and fossil fuels (de Boer, 2003). There are more issues related to ecological	Deleted: ,
256	performance, such as human toxicity, terrestrial and aquatic eco-toxicity, biodiversity,	
257	soil quality, and water use that are affect by a production system. These issues,	
258	however, were not addressed in this study, because there is no generally accepted and	
259	validated assessment method or because required data were not available	
260	(Thomassen, 2008).	
001		
201	Acidinication and eutrophication	Deleted: paragraph
262	The computation in this section, could not be based upon the technical data as given in	Delete de table
263	Table, 1, because relevant data were lacking. Computations were done for the	
264	conventional system and the organic system, in which broilers reach slaughter weight	Deleted: fast growing
265	in 43 days and <u>81 days, respectively</u>	Deleted: for slow growing broilers in 81 days
266	Ammonia (NH ₃) emission from animal manure is a major contributor to	Deleted: , and,
267	acidification (Groot Koerkamp, 1994). The NH ₂ emission per kg live weight, therefore,	Deleted: bird produced
268	is a relevant indicator for acidification (Thomassen and de Boer, 2005). Conventional	 Deleted: Groot Koerkamp et al. (1998) found that a conventional broiler
000		Deleted: our
269	brollers, on litter emitted on average 11.2 mg per n, which is 0.08 kg NH ₃ per bird place	Deleted: /day ×
270	per year (0.08 kg = 11.2 mg/h/bird_x_24 h x_(365/53) rounds x_43 days of	Deleted: ×
271	life)/1,000,000) (Groot Koerkamp et al., 1998), This value is used as the emission	Deleted:).
070	factor for broilers in the Netherlands (VROM 2002) Assuming a live weight of 2.1 kg	Deleted: laid down
212		Deleted: Dutch directive "Ammonia and animal husbandry"
273	per bird, 5.5 g NH ₃ volatilises per kg of <u>live weight annually</u> . For an organic system, the	Deleted: life
274	NH ₃ emission per bird place per year is unknown. <u>A conventional broiler, however</u> ,	Deleted: bird
		Deleted: broiler
		Deleted: We
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275	produces 1_275 kg manure in 43 days (Oenema et al., 2000), whereas an organic	1	Deleted: do know that a fast growing broiler
			Formatted: Font: Italic
276	broiler produces 3.4 kg per bird in 81 days (Gordon and Charles, 2002). Annually,		Deleted: a slow growing
277	therefore, a conventional broiler produces 8.8 kg of manure (1,275 x 365/53), whereas		Field Code Changed
			Deleted: a fast growing broiler, therefore,
278	an organic proiler produces 13.6 kg (3.4 x 365/91). In addition, a <u>conventional</u> broiler		Deleted: a slow growing
279	excretes 0.543 kg N per bird place per year (Groenestein et al., 2005), which converts		Deleted: fast growing
000		\sim	Field Code Changed
280	10,6.1% of total manure production. An organic, broller excretes 0.843 kg in per year,		Formatted: Font: Italic
281	assuming a similar N percentage in manure.		Deleted: (i.e.,
282	The NH ₃ emission of a conventional proiler was 0.08 kg NH3 per bird place per		percentage in manure, a slow growing
283	<u>year. or 0.066 kg N. Assuming a similar NH₃ emission factor of 12.1% (100 x</u>		Deleted: . The NH ₃ emission per bird place per year of a fast growing
004	0.000/0.540) the NUL emission of an expension busiley is 0.10 km N new bird place new		Deleted: , i.e.,
284	0.066/0.543), the NH ₃ emission of an organic broller is 0.10 kg N per bird place per		Deleted: %,
285	year, Based on a live, weight of 3.050 kg at 81 days, 8.3 g NH ₃ volatilizes per kg of live,		Deleted: is 0.10 kg N
		$\overline{\langle \cdot \rangle}$	Deleted: life
286	weight annually. Hence, annual NH ₃ emission per kg of <u>live</u> , weight is 51% higher for an		Deleted: bird
287	organic system than for a conventional system.		Deleted: bird
			Deleted: produced
288	The previous, computation was based on the assumption that the N content of	<u>(</u>	Deleted: above described
289	manure, and its related NH3 emission factor, were equivalent for conventional and		Deleted: is
			Deleted: are
290	organic systems. The N content of manure depends mainly on the composition of the	`. · _ ``	Deleted: fast
291	feed, and composition of the feed does not need to be different between the	````	Deleted: slow growing broilers
292	conventional and the organic system. The NH_3 emission factor, however, depends on		Deleted: . The N content of the diet between fast and slow growing broilers
293	the housing system, <u>stocking density, air temperature and velocity, and pH of manure</u>		
204	(Great Koarkamp, 1994). No information is available, however, to quantify the influence	1	Deleted: The total living space and stocking density, for example, which
234	(Croot Roerkamp, 1994). Not information is available, nowever, to quantify the infidence		differ between fast and slow growing
295	of these factors on NH ₃ emission.		emission factor (Groot Koerkamp, 1994). At this moment, however, no
296	Organic broilers must have an outdoor run for at least one third of their life (EU,		Deleted: In addition, the fact that organic birds spend time in the
297	1999), which might also influence the NH_3 emission factor. Emission of NH_3 in the		outdoor run influences the NH ₃ emission factor.
298	outdoor run depends on the time broilers spend outside, which itself depends on	1	Deleted: highly
200			Deleted: , e.g., weather
299	conditions, such as weather, season, temperature, facilities, and experience of the		Deleted auropth
300	broilers. The influence of an outdoor run on NH_3 emission is unknown, and requires	, ' '	Deleted. currently
301	further research. Besides its contribution to acidification, an outdoor run carries a risk to		
302	ecology regarding eutrophication through leaching of excess of nitrate and phosphate.		

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1		Deleted: 000 layers at an organic
2	303	It was found that 3.000 laying hens that could be outdoor from 11:00 h till sunset at an
3 4	304	organic commercial farm produced on average 2,845 kg N per ha per year (Aarnink et
5 6	305	al., 2006), which is higher than the legal limit of 170 kg N per ha per year (EU, 1991).
7 8	306	Furthermore, a large part of this manure was dropped close to the hen house, resulting
9	307	in an even increased risk for eutrophication. No such data exist for broilers with an
10 11 10	308	outdoor run, but it is clear that there is a risk for eutrophication in organic broilers.
12	309	Fossil-fueLuse and climate change
14 15	310	Regarding use of fossil fuels, we distinguished between direct and indirect use. Direct
16 17	311	use includes use of oil, gas, and electricity on the broiler farm, whereas indirect use
18 19	312	includes, use of fossil fuels for production and transport of farm inputs, such as,
20 21	313	concentrates. In <u>a</u> conventional <u>system</u> , 25% of the total <u>use of fossil fuels is</u> direct use
22	314	of electricity and gas at the farm, whereas 70% is indirect use for cultivation and
24	315	transport of concentrates (Spedding, et al., 1983; Vermeij, 2004). In <u>a</u> conventional Formatted: Font: Italic
25 26	316	system, direct use is electricity for mechanical ventilation and for lightning of the stable,
27 28	317	on average <u>about 0.15 kWh per bird per day</u> (Dyer and Desjardins, 2006). In <u>an</u>
29 30	318	organic system, natural ventilation is used and artificial light is used only in winter
31 32	319	(Rodenburg and van Harn, 2004). Therefore, electricity use was estimated to be 50%
33 34	320	lower for an organic compared with a conventional system (Vermeij, 2004). In addition
35 00	321	to electricity, a conventional system uses on average 0.09 m ³ gas for heating during
36 37	322	the first 3 weeks of production to maintain the body temperature of young chicks
38 39	323	(Vermeij, 2004). In an organic system, however, the amount of fossil fuels required for
40 41	324	heating is expected to double due to the lower stocking densities (Vermeij, 2004).
42 43	325	Overall, the direct use of fossil fuels is expected to be 25% higher for an organic
44	326	system compared with a conventional system (Vermeij, 2004).
40 46	327	Indirect use for, fossil fuels, required for the cultivation, and transport of feed above,energyproductioncounts energy useparameters [[14]
47 48	328	ingredients account for around 70% of the total use of fossil fuels. Concentrate
49 50	329	composition and feed conversion, therefore, are useful measures for indirect use of
51 52		13

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		Deleted: energy use
330	fossil fuels, Feed conversion (kg feed/kg gain) is 1.76 for the conventional system and	Deleted: equals
331	2.45 for the organic system (KWIN, 2003-2004; Vermeij, 2004). Indirect use of fossil	Deleted: production
000		Deleted: energy
332	tueis is expected to be higher in <u>an</u> organic <u>system</u> compared <u>with a conventional</u>	Deleted: production
333	system, due to this higher feed conversion. This expected increase, however, might be	Deleted: the
334	partly compensated for with lower use of fossil fuels for transport of feed ingredients	Deleted: Unless, this is
005		Deleted: energy
335	due to the use of locally grown feed. Overall, total energy use per kg of live weight	Deleted: Ellendorf et al.
336	varies in literature between 8.4–17 MJ for conventional production.(Ellendorff, 2002:	Field Code Changed
337	Williams et al., 2006; Blonk et al., 2007). For organic production, total energy use per	
338	kg of live weight is estimated to be 30-59% higher (Ellendorff, 2002; Williams et al.,	
339	<u>2006; Blonk et al., 2007).</u>	
340	Worldwide, the main green houses gasses (i.e. gasses that contribute to	Deleted: total energy use at 17 MJ per kg life weight for conventional and 27 MJ per kg life weight for organic
341	climate change), related to animal production are carbon dioxide (CO ₂), methane (CH ₄).	broiler production system. The
240	and nitrous oxide (N, Ω) (de Root 2002). Emission of CQ, is related to combustion of	Deleted: global warming,
342		Deleted: directly
343	fossil fuels and deforestation. Methane emission in broiler production results from	Deleted. Decedures direct and
344	manure only. Enteric methane emission from poultry is assumed to be negligible	indirect fossil energy use it
345	(IPCC, 2006). Nitrous oxide emission results mainly from application of fertilizer during	Deleted: suggested that a organic produced broiler contributes more
346	cultivation of feed ingredients. For conventional production, emission of green house	
347	gases per one kg of live weight of chicken is estimated at 2-3.2 kg expressed in CO_2	
348	units (IPCC, 2006; Williams et al., 2006). These estimates include green house gas	
349	emissions on the broiler farm and emissions during the production of transport of farm	Deleted: global warming than a conventional produced
350	inputs, such as concentrates (i.e. off-farm emissions). For organic production, emission	
351	of green house gases is estimated to be 50% higher (Williams et al., 2006). The lower	Deleted: .
352	feed conversion and use of organic feed explain the higher emission of green house	Deleted: reports that the production
353	gases in organic production	Deleted: broiler
		Deleted: needs 5.0 m ²
354	Land use	Deleted: broiler production and 9.6 m ² in organic broiler production
355	Land use (on and off-farm) in broiler production is reported to be 5.0 m ² per kg of meat $\int_{0}^{1} \int_{0}^{1} \int_{0}^{1} dt$	Field Code Changed
050		Formatted: Font: Italic
356	In <u>a conventional system (Bionk et al., 2007). For organic production, land use is a sub-</u>	make completely clear how they came to this result. It

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1	057		Deleted: likely that the
∠ 3	357	estimated to be 92-119% higher (Williams et al., 2006; Blonk et al., 2007). This	Deleted: a result of the fact that
4	358	difference between the conventional and organic system is because organic broilers	
5	350	were fed organic feed. The baryest per bectare of organically grown crops is generally	Deleted: are
6	555	were red priganic reed. The narvest per nectare of organically growing robs is generally	- Deleted: with
<i>(</i>	360	lower than that of conventionally grown crops. Hence, more land is used to produce for	Deleted: organic
8			Deleted: in general
9	361	1 kg of feed in <u>an organic system</u> than in <u>a conventional system</u> , Another factor that	- Deleted: feed production
10 11	362	might influence land use per kg of broiler meat is the feed conversion, which is higher	Deleted: which may
12	262	in erganic than in conventional broilers. The more food that is peeded to produce 1 kg	
13 14	303	in organic than in conventional brollers. The more leed <u>that</u> is needed to produce 1 kg	
15	364	of meat, the more land is needed for the production of feed.	
16 17	365		
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19	366	SOCIAL PERFORMANCE	
20			Deleted: Social issues¶
21	367	Animal welfare	/
22	507		Formatted: English (U.S.)
23 24	368	The Farm Animal Welfare Council (1992) formulated five freedoms that define ideal	- Formatted: Dutch (Netherlands)
25	369	states for animal welfare: 1) freedom from hunger and thirst: 2) freedom from	Formatted: English (U.S.)
26			
27	370	discomfort; 3) freedom from pain, injury or disease; 4) freedom to express normal	
28 29	371	behavior; 5) freedom from fear and distress. Mollenhorst et al. (2006) showed that	Deleted: cover the animal's basic needs.
30	370	behavioural studies provide relevant indicators regarding not only freedom to express	Formatted: Font: Italic
31	572	behavioural studies provide relevant indicators regarding <u>not only</u> needon to express	Deleted: To
32 33	373	normal behaviour, but also freedom from discomfort, fear, and distress. In addition, to,	,^
34 25	374	assess freedom from pain, injury or disease, indicators such as disease incidence or	
36	375	clinical observations appear relevant. From literature, we deduced the following five	
37	376	indicators for animal welfare in broilers: time spent on walking percentage of birds with	
38	570	indicators for animal wenare in broners, time spent on waiking, percentage of blids with	Deleted: foot pad disorders
39 40	377	footpad lesions, gait score, percentage of birds with heart, abnormalities, and mortality	Deleted: hearth
41	378	rate. Because behavioural and animal health studies with slow growing broilers are not	
42 43	379	always conducted within the constraints of organic production, it will be mentioned in	
44	0,0		
45	380	this section whenever a study was done within the organic constraints.	
46	381	Time spent on walking is used to judge physical abilities and canacities of a	Deleted: Walking behaviour
47	001	Time sport on waining is poor to judge private a contres and capacities of a	- Deleted: a parameter that is
48	382	broiler, Slow growing broilers spent twice as much time on walking than fast growing	Deleted: in several studies
49 50			Deletea: bira
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51 52			
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I		Deleted: Deiter and Kutaite (0001)
383	broilers at 6 weeks of age (Weeks, 2002). At 5 weeks of age, slow growers walked	found that
384	4.4% of their time, whereas fast growers walked 1.5% of the time, both housed with a	Deleted: at 5 weeks of age while
001		Deleted: /
385	stocking density of 20 birds per m ² (Reiter and Kutritz, 2001). This finding is in	
386	accordance with results of Bokkers and Koene (2003), who kept broilers in a lower	Deleted: /
0.07		Deleted: in their experiment. They showed
387	stocking density (4 birds per m ⁻) and found, that slow growers walked 6.7% of the	Deleted: and fast growers 2.0%
388	observed time at 6 weeks of age, whereas fast growers walked 2.0%. Percentage,	Deleted: . In both genotypes [15]
380	walking decreased to 5.8% in slow growers and to 1.2% in fast growers at 12 weeks of	Deleted: respectively of the [16]
000	waiking decreased to 5.0 % in slow growers and to 1.2 % in hast growers at 12 weeks of	Deleted: Compared to chicks [17]
390	age. Time, spent on walking is low in both fast and slow growers compared with chicks	Deleted: spent
391	of a layer line (13.4% at 6 weeks of age) (Bokkers, not published)	Deleted: of their time on walk [18]
001		Deleted: (Arens, 2000). In
392	Gait score is another way to study walking behaviour. Gait score has a six point	Deleted: experimental settin([19]
393	scale: from $0 = n_0$ detectable walking abnormalities to $5 = incapable of sustained$	Deleted: capacities of broiler [20]
000		Deleted: ,
394	walking on its feet (Kestin et al., 1992). A high gait score, therefore, means worse	Field Code Changed
395	walking behaviour and consequently an indicator for impaired welfare. Average gait	Pormatted: Font: Italic Deleted: The bigher the scor
		Deleted: The overall
396	score was 0.25 for slow growering and 2.18 for fast growing female broilers at 78 days	Deleted: growing
397	of age (Nielsen et al., 2003). One percent of the slow growing line, and 87% of the fast	Field Code Changed
000	munical line had a mait and a bigh and had distribute of (Nicham et al. 2020). East	Formatted: Font: Italic
398	growing line, had a gait score higher than 1 at that age (Nielsen, et al., 2003). Fast	Deleted: genotype
399	growing lines, had a gait score of 2.9 at 54 days of age and 3.8 at 81 days, whereas,	Deleted: genotype
400		Field Code Changed
400	slow growing lines, had a gait score of 1.5 at 54 days of age and 2.0 at 81 days (Kestin	
401	et al., 2001), Based on walking behaviour and gait scores, therefore, we concluded that	Deleted: genotypes
402	walking performance was better in slow growing broilers than in fast growing broilers	Deleted: of age, while
702	waiking performance was perform slow growing brokers that in hast growing brokers.	Deleted: genotypes
403	Fast growing broilers seemed to be physically restricted but the motivation to walk was	Deleted: 54 respectively
404	still present (Bokkers et al., 2007), which can be interpreted as a situation of reduced	Deleted: of age
		Deleted: it can be
405	welfare.	Deleted: is
406	Footpad lesions affect welfare because they might cause pain. Unfavourable,	Deleted: is
40 -		Field Code Changed
407	nousing conditions, such as moisture and chemical irritants in the litter, were	Formatted: Font: Italic
408	associated with footpad lesions (Ekstrand et al., 1998). Stocking density, activity of the	Deleted: Foot pad lesions ar [23]
400	birds, and leastion in the bauge affected littler quality (Corden, 1000; Sui et al. 2000;	Formatted: Font: Italic
409	birus, and location in the house anected litter quality (Gordon, 1992; Su et al., 2000;	Deleted: and genotype affect rank
410	Tasistro et al., 2004). Footpad lesions were found in 75.5% of fast growers and 1.5% in	Deleted: is therefore a usefu [26]

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2	411	slow growers at 84 days of age (Nielsen et al., 2003). In addition, 78.3% of fast	Deleted: an experimentthefoot togrowing broilersof a [[27]]
3	412	growers had footpad lesions at 40.5 days of age compared with 5.4% of medium slow	
5	413	growers at 50 days (van Horne <i>et al.</i> , 2003). In the UK, 14.8% of conventional reared	Formatted: Font: Italic
б 7	414	fast growing broilers had feetbad lesions at 20 days of age, whereas 0.6% of medium	dermatitiswhile genotypesfoot pad dermatit
8	414	last growing broners had <u>toopad resions</u> at 39 days of age, <u>whereas</u> 9.0 % of medium-	Field Code Changed
9 10	415	slow growing broilers had lesions at 49 days (Pagazaurtundua and Warriss, 2006).	Formatted: Font: Italic
11	416	Rodenburg et al. (2004) found more footpad lesions in fast growing (88.5% at 41 days	Deleted: foot
12 13	417	of age) and medium-slow growing (16% at 55 days of age) broilers with a roofed	
14 15	418	outdoor run than in fast growing (83.5% at 41 days of age) and medium <u>-slow growing</u>	
16 17	419	(11.5% at 55 days of age) <u>broilers that were kept indoors</u> . In both situations, the fast	
18	420	growing broilers had a higher prevalence than the medium-slow growing broilers.	
19 20	421	In an organic broiler production system, a prevalence of footpad lesions of	Deleted: Commercially grownbroilers hadappearsfood seemed to appearprovided
21 22	422	98.1% was found at 70 days of age (Pagazaurtundua and Warriss, 2006). A higher age	tobroilers in relation to foot pad lesions
23 24	423	and the outdoor run were associated with this high prevalence of footpad lesions. So, it	
25	424	appeared that results of different studies are contradictorily because footpad lesions	
20	425	appeared more frequently in fast growing broilers, but an outdoor run - as compelled in	
28 29	426	an organic broiler production system - also has negative consequences.	
30 31	427	Heart abnormalities, in broilers are associated with growth and, therefore, are, a	Deleted: problems seem to be in broilersobservedgrowing broilersgrowing broilers ([31])
32 33	428	useful indicator for welfare, Heart abnormalities were found, more frequently in fast	
34	429	growers (22.0%) than in slow growers (4.3%) at 12 weeks of age (Bokkers and Koene,	
35 36	430	2003). Mortality due to cardiovascular disorders was higher in fast growers, (2.1%) kept	
37	431	until 42 days of age than in medium <u>-slow growers</u> (0.4%) kept until 56 days of age (van	Field Code Changed
39	432	Horne, et al., 2003).	Formatted: Font: Italic
40 41	133	In animal production, mortality is the ultimate consequence of a failing	
42	400		Deleted: can be consideredas
43	434	biological-adaptation mechanism. Mortality, therefore, is an indirect or cumulative	broilersfor slow growing bro
44 45	435	animal welfare indicator. Mortality rate at commercial farms averages 4% for	
46	436	conventional systems, after 43 days (KWIN, 2006) and 3% for organic systems, after 70	
47 48	437	days (Tacken <i>et al.</i> 2003: Vermeij 2004). In two experiments, mortality rate for fast	Field Code Changed
49			Deleted: was 3.9% and 5.6 was
50 51	438	growers averaged 4.8% at 42 days of age and for medium slow growers averaged,	1.4% and[33]
52 53		17	

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439	1.5% at 56 days of age (van Horne <i>et al.</i> , 2003). Cause of death, such as heart failure.	Deleted: like
.00		Field Code Changed
440	is not well documented, in contrast to the number of deaths.	
441	Food safety	Deleted: Total mortality therefore is a good indicator but detailed data are needed to be able to quantify this issue properly.
442	Food safety refers to substances or organisms that <u>unintentionally contaminate</u> food	Deleted: are unintentional
443	and that are a health risk to the consumer. Broiler products mainly hold the risk of	Deleted: which do cause
444	being contaminated with antibiotic residues, and the bacteria Campylobacter spp., and	
115	Salmanella son	Deleted: There is
443	Samonena spp.	Deleted: against
446	Using antibiotics in animal production results in a high risk of organisms developing	Deleted: when using many antibiotics in animal production
447	resistance to antibiotics, especially when these organisms are infectious for animals	Deleted: are used both in human and animals
448	and humans. Resistance may occur when medicines such as tetracyclines and	Field Code Changed
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449	quinolones are used in animals and humans (Kramer et al., 2003). In a Dutch study,	Deleted: of conventional
450	residues of antibiotics were found in 8.3% broiler product samples of a conventional	Deleted: while this was 0%
.00		Deleted: organic
451	system, whereas there were found in 0% broiler products samples of an organic	Field Code Changed
150	system (Kramer et al. 2003) None of the samples exceeded the legal maximum	Formatted: Font: Italic
452	system (Marie, et al., 2003). Note of the samples exceeded the legal maximum	Field Code Changed
453	residue level as laid down by the European Union, (Kramer et al., 2003), Samples of	Deleted: (2005)
151	brailer products of both conventional and organic systems contained bacteria strains	Deleted: found that samples
404	biolier products of both conventional and organic systems contained bacteria strains	Deleted: Dutch
455	with resistance to several antibiotics (van der Zee et al., 2005). Samples of	Deleted: broiler products
450		Deleted: against
456	conventional system broller products, however, showed a higher resistance and a	Deleted: . Samples of conventional
457	resistance to more antibiotics than samples of an organic system (van der Zee et al.	against more antibiotics. In case resistance against a antibiotic was
458	2005). It seems, therefore, that meat from an organic system contains fewer residues	found in samples of both production systems, samples of the conventional
459	of antibiotics and has less antibiotic resistant micro-organisms than from a conventional	Formatted: Font: Italic
460	system.	Deleted: . Although based ut [35]
101		Deleted: (Humphrey, 2006)
461	Campylobacter spp. is a zoonotic pathogen of numans and an important cause	Deleted: Broiler meat is
462	of bacterial diarrhoeal disease worldwide (Humphrey, 2006), Broiler meat is	Field Code Changed
463	considered one of the most important sources of <i>Campylobacter</i> spp. infection for	Deleted: (Altekruse et al., 1994)
100		Deleted: . Measurements ca [37]
464	humans (Altekruse et al., 1994), Measurements to detect sources of risk can be	Field Code Changed
165	appropriate and a terms but also at brailer product outlate to access the direct state	Deleted: van der Zee
400	conducted not only at farms, but also at profiler product outlets to assess the direct fisk	Formatted: Font: Italic
ļ		Deleted: 2005)
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2	466	for consumers. The percentage of samples of fresh chicken products bought from		
3 4	467	supermarkets, poulterers, and butchers across the Netherlands and over 2003-2004,	/	Deleted: . In another Dutch study, no statistical difference was found between Campylobacter presence on
5 6	468	that were contaminated with Campylobacter spp. averaged 27.6% for a conventional	, [organic (49%) and on conventional (43%) broiler meat
7	469	system and 40.1 for an organic system (van der Zee <i>et al.</i> 2005). In another Dutch	{	Deleted: Kramer
8	100		{	Formatted: Font: Italic
9	470	study, there was no difference between Campylobacter presence in products of a		Deleted: 2003)
11	471	conventional system (43%) and an organic system (49%) (Kramer, et al., 2003)	[Deleted: . A Danish research for
12 13	472	Campylobacter presence at slaughter was 36.7% in birds of a conventional system and		and conventional broiler production using cloacal swabs at slaughter
14 15	473	100% in birds from an organic system (Heuer et al., 2001), indicating a high risk for the		showed that Campylobacter was isolated from 100% of organic flocks and from 36.7% of conventional flocks
16 17	474	meat to be contaminated at slaughter, especially organic broiler meat.		Field Code Changed
18	475	Salmonella spp. are a second group of zoonotic pathogens for which broiler	11	Deleted: Heuer
19	110		11	Formatted: Font: Italic
20	476	meat is a major cause of infections (Humphrey, 2006), and meat from conventional		Deleted: 2001)
21 22	477	systems tend to be contaminated more often. The percentage of samples of fresh		Deleted: indicating a high risk for the meat to be contaminated when birds are slaughtered, especially
23	478	broiler products taken over a whole year that were contaminated with Salmonella spp.	11	organic poultry meat. ¶ Salmonella spp. are a second group
24 25 26	479	averaged 9.3% for a conventional system and 2.8% for an organic system (van der Zee		of zoonotic pathogens for which broiler meat is a major cause of infections
20	480	et al., 2005). Salmonella contamination tended to be higher in conventional broiler		Field Code Changed
28	404			Deleted: (Humphrey, 2006)
29 30 31	481	(Kramer <i>et al.</i> , 2003).		tends to be contaminated with Salmonella more often. The percentage of samples of fresh
32 33	483	Product quality		chicken products taken over a whole year that were contaminated with <i>Salmonella</i> spp. was for conventional broilers 11.2% in 2003 and 7. ([38])
34	40.4			Field Code Changed
35	484	There are many aspects of a food product that determine its quality, e.g., eating quality,	111	Deleted: (van der Zee et al., 2005)
36	485	convenience, stability, wholesomeness, nutritive value (Erdtsieck, 1989). Because		Deleted: . Although in the stu [39]
38				Field Code Changed
30	486	eating quality is the most direct experience of a consumer. it is used often as a	$\left \cdot \right $	Deleted: (2003)
40	487	measurement for product guality. Eating guality includes characteristics such as texture	Ľ	Deleted: also no statistical [40]
41	-			Deleted: of a food product
42	488	(e.g., tenderness), appearance (e.g., colour), and flavour (taste and odour).	``\ \``Y	Deleted: with a product Deleted: in some studies
43 44	489	To be successful in an economic sense, a food product, in this case meat of a		Deleted: an
45	490	broiler, should meet the preferences and expectations of the consumer. To test this,		Deleted: Some aspects of ea [41]
46	404		",`{	Deleted: Is, therefore, hard to [42]
47 48	491	consumers are asked to judge broller products in blind tests. Farmer et al. (1997) used		Formatted: Indent: First line: 36 nt
49	492	8 trained panellists to compare breast and thigh meat from slow growing male broilers	Ì	Deleted: meat
50	102	e a allow partoniolo lo comparo biodot and angri mode nom biom growing <u>male biolicio</u>	`\{	Formattadi Fonti Italia
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493	(4.25 birds per m ² , but birds were not kept according to organic regulations) at 83 days	Deleted: slaughtered at
494	of age and fast growing male broilers (17 birds per m^2 conventionally kept) at 48 days	Deleted: slaughtered
101	or ago and had growing maio promote (17 binds per mi, conventionally reprivation days	Deleted: male broilers
495	of age, They found that the appearance of cooked breast meat from slow growers was	Deleted: of
496	more uniform in colour and had more visible moisture than from fast growers. They	Deleted: significant
497	found also that the texture of breast meat from slow growers was less tough, fibrous	Deleted: . In relation to texture they found
		Deleted: of the
498	and resistant to the knife than that from fast growers. Results for the same indicators,	Deleted: significant
499	however were the opposite when judging the thigh meat. A consumer papel of 100	Deleted: of the
-55	nowever, were the opposite when judging the tright meat. Apointumer parter of 100	Deleted: The results
500	found that breast meat from medium slow growers at 56 days of age was less juicy and	Deleted: parameters were
501	tender, and tougher than breast meat of fast growers at 42 days of age (van Horne et	Deleted: Van Horne et al. (2003) used a
		Deleted: persons and
502	al., 2003). No difference was found for thigh meat. Another consumer panel of 90 found	Deleted: of
502	no difference for tanderness between breast meet of alow growing breilers with outdoor	Deleted:
505		Deleted: slaughtered
504	access and fast growing broilers kept indoor, both slaughtered at the same weight	Deleted: slaughtered
505	(Fanatico <i>et al.</i> , 2006). Juiciness of breast meat from fast growers kept indoors was	Deleted: in that study. Fanatico et al. (2006) also used a
		Deleted: (
506	judged better than from slow growers with access to outdoors.	Deleted: persons) and
507	Eurthermore, breast meat from fast growers had a bigher odour intensity than	Deleted: of
507	r uniternole, breast meat normast growers had a higher odour intensity than	Deleted: of
508	breast meat from slow growers (Farmer, et al., 1997). <u>Breast</u> meat of medium-slow	Deleted: outdoor
		Field Code Changed
509	growers, however, had a better odour and appearance than fast growers (van Horne et	Formatted: Font: Italic
510	al 2003) In thigh meat the odour intensity qualified as "chicken odour" and "abnormal	Deleted: Van Horne et al. (2([44])
010		Deleted:
511	odour", was higher in fast growers than in slow growers (Farmer, et al., 1997). Fast	Deleted: significant
F10	average least indexes accord a bight of far flat only of this is most the solar symptome with	Deleted: growing broilers
512	growers kept indoors scored a nigher for liavour of triigh meat than slow growers with	Formatted: Font: Italic
513	access to outdoors (Fanatico et al., 2006), but Farmer et al. (1997) did not find such a	Eield Code Changed
514	difference for flavour.	Deleted: the
515	In studies on product quality a large number of factors affect the outcome, such	Deleted: autoor
0.0		Deleted: A problem with the
516	as age, genotype, sex and weight of the birds; feed, housing system, way of preparing	Deleted: are the
F17	the complex and sultural background of the negativity. These feature uses not similar	Deleted:
51/	the samples, and cultural background of the panellists. These factors were not similar	Deleted: that have an affer star
518	between different studies, which makes a comparison between, and interpretation over	Deleted: final
		Deleted: of the results
519	studies hard. Product quality, nevertheless, can be a useful indicator when used	Deleted: in the future
520	carofully	Deleted: these confounding f
520	<u>carciuny</u>	(

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2	521	Working conditions
3 4	522	Working conditions concern the farmer. Relevant indicators for working conditions
5	523	include, for example, working hours, and number of physical and psychological
6 7	524	complaints related to work (Dinten <i>et al.</i> , 2006; Mollenhorst <i>et al.</i> , 2006), Although
8	505	Field Code Changed
9 10	525	there are a number of indicators regarding working conditions, there is little information
11	526	on the effects of barn conditions on human health. No comparative studies were found
12 13	527	regarding conventional and organic systems.
14	528	Several studies were conducted on the levels of dust and gaseous pollutants in
15 16	529	broilers houses that might be detrimental for humans. Main sources of dust are from
17 18	530	feed, litter, and the broilers themselves (Wathes, 2004). Dust can carry bacteria,
19	531	viruses, and endotoxins (Takai et al., 1998). Takai et al. (1998) discriminated between
20 21	532	respirable dust (between 0.5 – 7 µm) and inhalable dust (between 7-20 µm). Amount of
22 23	533	dust is dependent on time of day, time of production period, ventilation, moisture,
24 25	534	animal activity, etc. In Dutch broiler houses, a mean concentration of 1.05 mg/m ³
26	535	respirable dust and of 10.4 mg/m ³ inhalable dust, and a mean concentration of 41
28	536	ng/m ³ respirable endotoxins and of 381 ng/m ³ inhalable endotoxins were found (Takai
29 30	537	et al., 1998). Dust and the attached endotoxins in the pig house caused disorders in
31 32	538	the bronchi and lungs of the farmer (Donham et al., 1984; Vogelzang, 1999; Von Essen
33 34	539	et al., 2005). Bongers et al. (1987) concluded that respiratory problems are found more
35	540	frequently in farmers than in other professional groups.
37	541	Gaseous pollutants also affect working conditions. Ammonia, for example,
38 39	542	irritates eyes and respiratory system. In the EU, the maximum acceptable
40	543	concentration for ammonia is 50 ppm. For poultry houses, it is advised to keep
41 42	544	ammonia concentration below 25 ppm, because above this level ammonia has a
43 44	545	detrimental effect on the body weight gain of chickens (Miles <i>et al.</i> , 2004) and severity
45 46	546	of clinical corneal lesions increased (Miles <i>et al.</i> , 2006). In the Netherlands, an
47	547	ammonia concentration of 11.2 ppm was found in conventional broiler houses with
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548	peaks up to 40 ppm (Groot Koerkamp et al., 1998), but no such studies were found for		
549	organic broiler production .		Deleted: No comparative studies, however, were found for indicators concerning working conditions in the field of broiler production. ¶
550	GENERAL DISCUSSION AND CONCLUSION		Deleted: defined
	¥=====================================		Deleted: societal
551	The objective of this study was to gain more insight into the contribution to sustainable	11	Deleted: broiler production system
551			Deleted: are highly depending
552	development of two broiler production systems, conventional and organic, by	14	Deleted: poultry
553	quantifying issues related to economic, ecological, and social performance. Our results		Deleted: Both may fluctuate over years. So, data
FF A			Deleted: just
554	showed that economic performance was better for the organic system than for the	"	Deleted: indicated
555	<u>conventional system</u> , but that economic results depend on the market price for broiler \int_{a}^{b}		Deleted: therefore
	/	11	Deleted: interpret
556	meat and <u>on feed costs. Data on economic performance, therefore, are valid for a</u>	<u>"</u>	Deleted: seemed to be
557	specific time period and should be interpreted with care		Deleted: broiler production
557	specific finite period and should be interpreted with care.	11	to
558	Regarding ecological performance, on-farm ammonia emission per kg live		Deleted: broiler
F F 0		' i,	Deleted: Since most
228	weight was nigher in an organic system that in a conventional system. Because of the 7	11,	Deleted: energy
560	outdoor run, organic production has an increased risk for eutrophication. Moreover,	11	Deleted: used for the production of
		14	Formatted: English (U.K.)
561	emission of green house gasses, use of fossil tuels and land required for the		Deleted: and slow growing broilers convert
562	production of one kg of live weight is higher for an organic than for a conventional	";;,	Formatted: English (U.K.)
563 564	system. This is mainly due to a lower feed conversion in an organic system and use of organic feed.		Deleted: less efficient than fast growing broilers, the contribution to global warming will be higher in slow growing broiler production systems; unless the extra energy needed is
565	Regarding the social issue of animal welfare, many studies have been		compensated with a high use of local grown feed which deceases energy use. Several issues were elab
566	conducted that have lead to a variety of suitable indicators. Not all indicators are ready		Deleted: societal
500			Deleted: which has
567	to use. Total mortality, e.g., is a good indicator, but detailed data are needed to be able		Formatted: English (U.K.)
500	to example of the state of the	1	Deleted: be concluded
568	to quantity causes of death property. From these studies, we can conclude that slow	1	Deleted: growing broilers
569	growers in organic or extensive systems have better chances to maintain an	12	Deleted: production
			Deleted: perspectives
570	acceptable level of welfare than fast growers in conventional systems.		Deleted: level
571	Regarding the social issue of food safety, meat from an organic system was		Deleted: growing broilers
571	regarding the social issue of food safety, meat norm an organic system, was		Deleted: intensive production
572	never found to be contaminated with antibiotics, in contrast to conventional system, In		Deleted: slow growing broilers
E 70	most of both systems, however, entiblistic resistant exceptions were found. The side for	×.,	Deleted: beel
5/3	meat of both systems, nowever, antibiotic resistant organisms were found. The risk for		Dereteu: proner meat

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Campylobacter contamination in broiler meat was higher in an organic system than in a

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575	conventional system, whereas the risk for Salmonella contamination was lower. In both	Deleted: organic broiler production while
		Deleted: Hence, in
576	systems, therefore, improvements can be made in relation to food safety.	Deleted: production
577	Product quality has been found to be a difficult issue to quantify. Although	
578	several studies on product quality were found, results were difficult to compare and to	
579	interpret due to multi-factorial effects. In future studies more attention should be paid to	
580	these factors influencing product quality.	Formetted, Todarta First lines, 20
581	Finally, no data were found to quantify issues relating to working conditions.	Formatteu: Indent. First line. 50
582	Indirect variables were described, and that could give an indication, but these variables	
583	were only available for <u>a conventional system of broiler production</u> .	Deletede for equeral issues
584	Although assumptions had to be made for several issues, basically the	
585	methodology of Mollenhorst and De Boer (2004) was useful to assess sustainable	
586	development in these two defined broiler production systems. It has become clear now	(-
587	that the studied systems differ and what knowledge is lacking to make a good	Deleted: where
		Deleted: kind of
588	comparison for all issues. To increase our knowledge, a next step should be an	Deleted: about different issues
589	integrated, on-farm assessment. By collecting data on farms, a quantification of all	Deleted: relevant
500	indicators about the passible. In that way, insight can be gained into how insues offset	Deleted:
590	indicators should be possible. In that way, insight can be gamed into now issues anect	Deleted: relevant
591	each other and thus into the trade-offs when taking measurements to innovate a broiler	Deleted: in Deleted: change something in
592	production system.	
F00 '		Deleted: over
593	In conclusion, this study showed that changing to <u>an organic</u> production	Deleted: a slow growing
594	system has consequences for more than only animal welfare. Although it is difficult to	Deleted: much more
595	compare different indicators for each issue, it is necessary to study the contribution to	
		Deleted: relevant
596	sustainable development of all issues. An integrated on-farm assessment is needed to	- Deleted: After this approach base upon current knowledge, an
597	fill in the gaps. In this way a production system can be developed that is economically	Deleted:
598	profitable ecologically sound and socially acceptable	Deleted: acceptable for society,
000	promotion_poologically country_cooperate.	Deleted: and
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555	AGIAROWEEDGEMENT	Formatted: Default Paragraph Fo
600	We would like to thank Marieke Klaasen for her valuable help with collecting data and	English (U.S.)
601	Mike Grossman for improving the English and the readability of this paper.	Formatted: Body Text 2 Formatted: Default Paragraph Fo
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Table 1: Technical data of a conventional	and an organic broiler p	roduction system for	Deleted: (KWIN, 2003-2004, 2006) Deleted: (Vermeij, 2004) Deleted: the year
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	Broiler, product	tion_system	Deleted: Broilers
Technical data	Conventional	Organic	
Birds, at the start of a round (number)	70 <u>.</u> 000	16,000	Deleted: Number of birds
Duration of a round (days)	43	70	
Empty for cleaning (days)	10	10	
Rounds per year <u>(number)</u>	6.9	4.6	
Space inside (birds $per_{m}m^{2}$)	22	10	Deleted: /
Space outdoor (m ² per bird)	0	<u>4*</u> _	Formatted: Not Superscript/ Subscript
Mortality (%)	3.3	2.8	Deleted: /
Birds, slaughtered per round (number)	67 <u>.</u> 690	15,552	Deleted: Number of birds
Slaughter weight (g)	2 <u>.</u> 100	2,600	
Total delivered (kg per year)	980 <u>.</u> 828	186 <u>.</u> 002	Deleted: /
Growth (g per_day)	50.8	36.5	Deleted: /
Feed conversion (ka feed per ka growth)	1.73	2.45	Deleted: /
Eeed intake per round (a per bird)	3 634	6 370	Deleted: /
	<u>5,054</u>	0.010	Deleted: / round
Water intake per round (I per bird)	7.0	11.5<	Deleted: /
*the outdoor run must be accessible a	at least 1/3 of their life		Deleted:
Source; conventional (KWIN, 2003-20	004, 2006); organic (Verme	ij, 2004)	Deleted:Page Break
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	Table 1: Technical data of a conventional 2003. Technical data Birds, at the start of a round (number) Duration of a round (days) Empty for cleaning (days) Rounds per year (number) Space inside (birds per,m²) Space outdoor (m² per,bird) Mortality (%) Birds, slaughtered per round (number) Slaughter weight (g) Total delivered (kg per,year) Growth (g per,day) Feed conversion (kg feed per,kg growth) Feed intake per round (g per,bird) Water intake per round (l per, bird) *the outdoor run must be accessible a Source; conventional (KWIN, 2003-20)	Table 1: Technical data of a conventional and an organic broiler p Broiler, product Broiler, product Technical data Conventional Birds at the start of a round (number) 70,000 Duration of a round (days) 43 Empty for cleaning (days) 10 Rounds per year (number) 6.9 Space inside (birds per, m²) 22 Space outdoor (m², per, bird) 0 Mortality (%) 3.3 Birds slaughtered per round (number) 67,690 Slaughter weight (g) 2,100 Total delivered (kg per, year) 980,828 Growth (g per, day) 50.8 Feed conversion (kg feed per, kg growth) 1.73 Feed intake per round (g per, bird) 7.0 The outdoor run must be accessible at least ½ of their life Source; conventional (KWIN, 2003-2004, 2006); organic (Verme	Table 1: Technical data of a conventional and an organic broiler production system for

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Table 2: Economic data of a conventional and an organic broiler production system for

the year 2003.

	Broilers product	ion system	Formatted Table
Economic data (EUR per bird),	Conventional	Organic	Formatted: Superscript
	0.71	1 82	Deleted: (€/kg meat)
	0.07	0.50	Deleted: (€/bird)
Purchase price chicks,	0.27	0.50	Deleted: (€/100 kg)
Feed costs,	23.15	35.75	 Deleted: (€/bird)
Health care	0.045	0.120	Deleted: (C/bind)
	0.02	0.01	
Heating,	0.03	0.05	Deleted: (€/bird)
Water	0.010	0.016	Deleted: (€/bird)
Redding	0.01	0.04	Deleted: (€/bird)
Ootabian and landing	0.01	0.05	Deleted: (€/bird)
Catching and loading,	0.04	0.05	Deleted: (€/bird)
Animal health levies,	0.007	0.007	
Carrion collecting service	0.002	0.002	Deleted: (6/bird)
Manure transport	0.0264	0.00	
nterest livestock	0.0191	0.0191	

2006); organ. Source: conventional (KWIN, 2003-2004, 2006); organic (Vermeij, 2004)

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British Poultry Science

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production system for <u>2003 in EUR per FTE</u>			De
Broiler production system	Conventional,	Organic	 (€/I
Total revenues	696387.95	338523.49	De (€/I
Variable costs			
Feed	399 <u>.</u> 629.38	165 <u>.</u> 260.94	
One-day-old chicks	130 <u>.</u> 410.00	36 <u>.</u> 800.00	
Health care	21 <u>.</u> 735.00	8 <u>.</u> 832.00	
Electricity	9 <u>.</u> 660.00	736.00	
Heating	14 <u>.</u> 490.00	3 <u>.</u> 680.00	
Water	4 <u>.</u> 830.00	1 <u>.</u> 209.14	
Bedding	4 <u>.</u> 830.00	2 <u>.</u> 944.00	
Catching and loading	19 <u>.</u> 320.00	3 <u>.</u> 680.00	
Animal health levies	3 <u>.</u> 381.00	515.20	
Carcass collecting service	966.00	147.20	
Interest livestock	9 <u>.</u> 225.30	1 <u>.</u> 405.76	
Total variable costs	618 <u>.</u> 476.68	225 <u>.</u> 210.24	
Fixed costs			
Depreciation and maintenance of buildings	25 <u>,</u> 772.73	10,240.00	
Depreciation and maintenance of inventory	18 <u>.</u> 931.82	4 <u>.</u> 080.00	
Outdoor run	0.00	8 <u>.</u> 640.00	
Manure transport	12 <u>.</u> 751.20	0.00	
Control levies organic	0.00	3 <u>.</u> 940.00	
Other fixed costs	13 <u>.</u> 000.00	13 <u>.</u> 000.00	
Total fixed costs	70 <u>.</u> 455.75	39 <u>.</u> 900.00	
Net farm income	7 <u>.</u> 455.52	73 <u>,</u> 413.26	

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has much more consequences tha	n	
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. Although it is difficult to compare c	lifferent indicators for	each issue, it is necessary to
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the contribution to sustainable dev	elopment of all releva	nt issues. An
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for that. In this way a production sy	vstem	
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economic profitable and eco	logically sound	12/23/2008 12:35:00 PM
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in egg production systems. Organi	c regulations, for exar	nple, determine that animals
should have outdoor access for a c	ertain period of their li	fe or of the year. This might
have, next to improved animal welfa	are, negative environr	nental consequences such as a
higher ammonia volatilisation or niti	rogen leaching	
Page 4: [9] Deleted . Making a well reasoned ho	bokke001 listic consideration wh	12/23/2008 12:35:00 PM nether one production system
contributes more to sustainable dev	elopment than anothe	er, therefore, requires a
comparison of the economic, ecolog	gical and societal perf	ormance of both production
systems. In other words, the contrib	oution of a system with	n slow growing broilers and a
system with fast growing broilers to	sustainable developn	nent should be assessed. In this
study, we compared the combined	economic, ecological	and societal performance of a
defined organic production system	with slow growing bro	ilers with a defined conventional
production system with fast growing	n broilers	

MATERIALS AND METHODS

The four step methodology used in this study is based on ideas of Bell and Morse

Page 5: [10] Deletedbokke00112/23/2008 12:36:00 PMand seems to be useful to apply for other production systems as well. It consists of thefollowing steps: 1) description of the problem situation and of the system in study, 2)identification and definition of relevant economic, ecological en societal issues, 3)selection and quantification of indicators for each issue, and 4) final assessment of thecontribution to sustainable development. These four steps are described in more detail.

Step (1): Description of the problem situation and the system in study

The first step requires a description of the problem situation and of the systems in study. The problem situation is described in the introduction. The systems in study are a defined conventional broiler production system with fast growing broilers and a defined organic broiler production system with slow growing broilers managed by one full time equivalent. The system boundary is therefore the farm with inputs such as feed, water, electricity, medicines, litter, one-day old chicks, etc., and with broilers for slaughter and manure as output.

Step (2): Identification and definition of economic, ecological and societal issues

The second step implies the selection of economic, ecological and societal (EES) issues relevant regarding sustainable development of a broiler production farm. Based on recent assessment studies (Mollenhorst and de Boer, 2004; van Calker et al., 2004), we selected the following EES issues: economic performance

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is on average 4.0% for fa	ast growing brollers	
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for slow growing broilers	3%	
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was 3.9% and 5.6		
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was 1.4% and		
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. Samples of conventional brolle	is showed nowever resist	ance against more antibiotics.
In case resistance against a ant	ibiotic was found in sampl	as of both production systems
In case resistance against a ant	blotic was found in sampl	es of both production systems,
samples of the conventional pro	duction method had a high	her resistance than the organic
samples of the conventional pro	duction method had a high	ner resistance than the organic
samples		
Samples		
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. Although based upon only two	studies, it seems that orga	anic poultry meat contains
fewer residues of antibiotics and	I has less antibiotic resista	ant micro-organisms.
Campylobacter spp. is a zoonot	ic pathogen of humans an	d an important cause of
bacterial diarrhoeal disease wor	Idwide	
	halde 004	12/22/2000 12-20-00 PM
Broilor most is conside	prod one of the most impo	12/23/2008 12:30:00 PM
	red one of the most impor	tant sources of Campyiobacler
sph. infaction for humans		
spp. Intection for numaris		
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. Measurements can be conducted at farms to detect sources of risk but also at broiler product outlets to assess the direct risk for consumers. The percentage of samples of fresh chicken products bought in supermarkets, from poulterer and from butchers spread over the Netherlands and over a whole year which were contaminated with C*ampylobacter* spp. was for conventional broilers 25.9% in 2003 and 29.3% in 2004 and for organic broilers 36.3% in 2003 and 43.9% in 2004

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. Conventional pou	Itry meat tends to be contaminated with	th Salmonella more
often. The percentage of s	amples of fresh chicken products take	en over a whole year that
were contaminated with Sa	almonella spp. was for conventional bi	roilers 11.2% in 2003
and 7.4% in 2004, and for	organic broilers 3.4% in 2003 and 2.1	% in 2004

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. Although in the study of	f Kramer et al.	

Page 19: [40] Deletedbokke00112/23/2008 12:36:00 PMalso no statistical difference was found, salmonella contamination on organic

broiler meat (4%) tended to be lower than on conventional broiler meat (8%).

Page 19: [41] Deletedbokke00112/23/2008 12:36:00 PMSome aspects of eating quality can be measured objectively, but most aspects are

subject to individual or cultural preferences and expectations.

Page 19: [42] Deletedbokke00112/23/2008 12:36:00 PMis, therefore, hard to define but it

Page 19: [43] Deletedbokke00112/23/2008 12:36:00 PM) which in studies are judged, e.g., a five or nine point Likert scale.

Page 20: [44] Deletedbokke00112/23/2008 12:36:00 PMVan Horne et al. (2003), however, found that breast

Page 20: [45] Deletedbokke00112/23/2008 12:36:00 PMFanatico et al. (2006) found that fast

	British Poultry Science	
Page 20: [46] Deleted , that have an affect o	bokke001 n the outcome. This	12/23/2008 12:36:00 PM
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these confounding fac	tors are taken into account	
Page 22: [48] Deleted less efficient than fast	bokke001 growing broilers, the contribution	12/23/2008 12:36:00 PM ution to global warming will be
igher in slow growing broiler	production systems; unless t	he extra energy needed is
compensated with a high use	of local grown feed which de	ceases energy use. Several
sues were elaborated for so	cietal performance.	