

A Review of Recent Publications
On Animal Welfare Issues
For Table Egg Laying Hens

(Welfare and Socio-economic issues)

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Table of contents

- A. Relative costs associated with cage, barn (litter) and free range egg production (US) – pages 1-9**
- B. The EU Directive 1999/74/EC establishing minimum standards for table egg layer systems – pages 10-13**
- C. Study on the socio-economic implications of various systems for laying hens – page 14**
- D. The welfare aspects of various systems – pages 15-19**
- E. USDA Foreign Agricultural Service evaluation of the economic effects of the abolition of cages in the EU – page 19**
- F. Will Germany actually ban cages in 2007 – pages 19-21**
- G. Summary of the pros and cons of cage and non-cage systems – pages 22-23**
- H. General tables relative to the table egg industry in the EU – pages 24-26**
- I. Selected references – page 27**

A. Relative Costs Associated With Cage, Barn (litter) and Free-Range Egg Production

Note: The following discussion is based upon the stated assumptions and does not represent an actual comparison of such facilities. It is presented as an example of the cost considerations association with producing eggs in the three different production systems. The original paper was written in November 2000. Modifications in certain assumptions were made in September 2005.

We're not aware of any "official" definitions for these types of eggs at the USDA level. California has an un-official definition of "Free Range" - "True free-range eggs are those produced by hens raised outdoors or that have daily access to the outdoors". This is not actually described in the published regulations. Descriptive terms (other than for traditional eggs) must be approved by the California Department of Food and Agriculture (CDFA). The terms "organic" or "organically produced" are allowed only if the producer is licensed as an organic producer by CDFA. It is assumed that any label such as "free range", "cage free", "barn eggs", etc. would have to be approved by CDFA or a comparable state agency. The proposed label would be compared to the practices claimed.

The above definition of free range probably does not define the practice in the detail needed or the one that the consumer envisions. There's a big difference between placing 400 birds on one acre of a green pasture in the UK or France and merely having a door open to an outside bare pen. Obviously, there's also a major cost difference.

Cost differences depend upon:

1. Relative cost of buildings and equipment
2. Labor requirements
3. Land costs
4. Relative performance

Egg price differences depend upon:

"Whatever the market would bear depending upon the total supplies and demand for alternative products". Today's price relationships would have no bearing on prices in the future if all eggs had similar requirements relative to the type of system used.

In a 1996 US study, white eggs were priced (at the supermarket) at \$1.23 per dozen while "specialty" eggs were priced at \$2.18. Five types of specialty eggs were seen. Prices for the different types are shown in Table A-1.

Table A-1. Specialty Egg Prices in US Supermarkets - 1996

Type of product	Price per dozen
a) All vegetable diets	\$2.19
b) Welfare managed	\$2.29
c) Nutritionally altered	\$1.81
d) Fertile	\$2.24
e) Organic	\$2.72

In general terms, "Barn eggs" would probably represent \$.50 to \$.75 per dozen premiums while "Free-Range eggs" would receive a \$1.00 to \$1.50 per dozen premium. This varies between states with California supermarkets at the high end of the range compared to other states.

A-A. RELATIVE INVESTMENT COSTS - BARN EGGS VS CAGE EGGS

Assumptions:

** No differences in performance (egg production, mortality, or egg size) are assumed even though individual studies may show small differences in one or more of these factors.*

1. The publication "Broiler Production Systems in Georgia - Costs and Returns Analysis - 2000" by Dan Cunningham lists building, equipment and mechanical nest costs at \$9.50 per square foot for floor breeder houses. This would be a comparable investment for a "barn-type" non-cage system. At 2 square feet per bird, this would represent \$19.00 per bird. A comparable figure for a cage layer house would be about one-half this much (\$9 per bird). This would result in 5.2 ¢/dozen higher egg production cost for the barn system (depreciation and interest).
2. Cunningham lists a litter cost of \$1600 per year for 20,000 birds or \$.08 per bird - 0.4 ¢/dozen added costs for the barn system.
3. A labor cost of 3.5 ¢/dozen for producing cage eggs is typical. Even though the barn house has mechanical feeding and egg collection, it is assumed at least 50% more labor would be required for the daily chores in this type of housing - an increase of 1.75 ¢/dozen.

4. Additional costs for medication (coccidiosis and internal parasites) associated with the barn method are assumed to be 5 cents per bird - an increase of 0.23 ¢/dozen.

5. It is assumed that 3% of the eggs are lost (dirty floor eggs and leakers) with no value compared to 1% for cages - a cost of 1.1 ¢/dozen.

6. It is assumed that barn eggs will require 10% higher feed costs per dozen due to expected higher feed consumption and wastage - a 2.2 ¢/dozen increase.

7. Assuming \$10,000/acre for land and a 10%/year cost, the land for the cage system would cost 0.125 ¢/dozen (@ 1/4 square foot per bird) and 1.00 cent per dozen for the barn house (@ 2 square feet per bird). This assumes total land requirements = 5x the floor space of the housing. A summary of costs is listed in Table A-2.

Table A-2. Estimated Egg Production Costs for Barn and Cage Housing (cents/dozen)

Item	Cage System	Barn System	Difference
Feed	22.50	24.70	2.20
Pullets	6.60	6.60	0
Labor	3.50	5.25	1.75
Misc.	5.00	5.00	0
Housing & Equip. Depreciation	3.30	6.50	3.20
Housing & Equip. Interest	2.10	4.10	2.00
Litter	n/a	0.40	0.40
Additional Medication	n/a	0.23	0.23
Additional loss eggs	n/a	1.10	1.10
Cost of Land	0.13	1.00	0.87
Total	43.13	54.88	+11.75

A-B. FREE RANGE COMPARISON WITH CAGE EGG COSTS

Assumptions:

** No differences in performance (egg production, mortality, or egg size) are assumed even though individual studies may show small differences in one or more of these factors.*

1. Housing and equipment Housing needs for the free-range system are assumed to be minimal - a simple covered house for nesting and feeding. Eggs would be hand gathered and feeding would be done in the house by hand. We assume one house on five acres of land and a flock of 2000 chickens (400 birds/acre). House plus minimal equipment are estimated to cost \$5.00/bird or \$10,000 per unit. This population density is very low, but represents densities required in certain systems in Europe. Doubling the number of hens per acre would reduce costs by an estimated 5.7 ¢/dozen.

2. Litter costs for floor of nesting house = 0.1 ¢/dozen

3. Labor costs: one person @ \$10/hr x 8 hrs/day x 365 days/year = 16.6 ¢/dozen.
It is assumed that one person could handle 4 such set-ups or 8,000 birds x 22 dozen per bird/year (176,000 dozen/year). Approximately 4 hours per day would be required for hand egg collection. Feeding and care of the 20-acre farm would require the remaining 4 hours per day.

4. Fencing 8,400 feet x \$3/ft x 15 year life and 10% interest x half value
Total investment = \$25,000

Annual cost = \$1,680 depreciation + \$1,260 interest = \$2,940/176,000 dozen =
1.67 ¢/dozen

5. Medication cost (same as barn house) = 0.25 ¢/dozen

6. Additional loss eggs (2x barn house) = 2.20 ¢/dozen

7. Higher feed costs (same as barn) = 2.0 ¢/dozen
(could be less because of pasturing)

8. Higher land cost (400 birds/acre or 109 sq. ft./bird) = 11.4 ¢/dozen

9. Pasture maintenance and irrigation = \$100/acre = 1.14 ¢/dozen.

A summary of costs is listed in Table A-3.

Table A-3. Estimated Egg Production Costs for Free-Range and Cage Housing (cents/dozen)

Item	Cage System	Free-Range System	Difference
Feed	22.50	24.70	+2.20
Pullets	6.60	6.60	0
Labor	3.50	16.60	+13.10
Misc.	5.00	6.67 *	+1.67
Housing & Equip. Depreciation	3.30	1.82	-1.48
Housing & Equip. Interest	2.10	1.14	-0.96
Litter	n/a	0.10	+0.10
Additional Medication	n/a	0.25	+0.25
Additional loss eggs	n/a	2.20	+2.20
Cost of Land	.13	11.4	+11.3
Total	43.13	71.53	+28.40

* Includes pasture and fencing maintenance and irrigation.

Table A-4. Summary of Costs by System – Estimated for US

System	Estimated Cost of Production (¢/doz)	Difference from cage in ¢/doz)	Difference from cage in %
Cage	43.13	n/a	n/a
Barn (litter)	54.88	+11.75	+27.2
Free-range	71.53	+28.40	+68.8

Comments:

The large differences in costs for free range eggs are due to:

- 1). Greatly increased land requirement
- 2). Higher labor requirements.

Land use must be paid for whether it is leased or owned. We've assumed \$10,000/acre land costs. Reducing land cost to \$5,000/acre would reduce the free-range costs by 5.7 ¢/doz. A similar reduction in space requirement (50%) would give a similar reduction in costs (5.7¢/doz.). If land values were reduced by 50% and bird density per acre were increased by 50%, the resulting net cost of land would be reduced from 11.4 ¢/dozen to only 2.9¢/dozen.

Other systems for managing table egg layers include aviary housing and enhanced (furnished) cages. Equipment and housing costs are currently not available to the author for these systems. A similar analysis approach can be used with these types of houses once the costs are established.

The author has chosen to use similar performance profiles for the current analysis. This is undoubtedly not true. This was necessary because of the newness of some of the systems and suitable comparative data was not available.

A-C. Supplemental Comments

As discussed earlier, the most significant effects of removing laying hens from cages and placing them under free-range conditions would be in increased labor costs and higher investments in land.

Land Requirements

Some European standards for free-range management allow no more than 400 hens per acre. This would require the following amount of land for various situations:

Table A-5. Land Requirements for Various Situations (assuming 400 hens/acre for the free-ranges system and 50,000 hens/acre for a typical cage system)

Descriptions	Est. Hens*	Cage	System	Free-range	System
		Acreage	Square miles	Acreage	Square miles
The entire U.S. egg industry	275	5,500	8.59	687,500	1,074
The state of Iowa	40	800	1.25	100,000	156
The state of Ohio	28	560	.88	70,000	109
The state of Pennsylvania	23	460	.72	57,500	90
The state of Indiana	22	440	.69	55,000	86
The state of California	20	400	.63	50,000	78
A typical large egg farm	1	20	.03	2,500	3.9

* In millions

In summary, conversion of existing cage facilities to free-range systems would increase land requirements by 125-fold. At \$5,000 per acre, investments in land would increase from \$27.5 million to more than \$3.4 billion. Land investments per hen would increase from \$.10 per hen to more than \$12 per hen. The investment in land at \$5,000 per acre would increase costs by approximately 5 cents/dozen.

Labor Requirements

The amount of labor required for the two systems is highly dependent upon whether or not eggs are gathered by hand or by conveyor belt. Based upon the assumptions used in Table 3, the cage system would have labor costs of 3.5 ¢/dozen compared to 16.6 ¢/dozen for the free-range system. This is a 4.7 fold increase in labor requirements. The free-range system would require 17,000 employees compared to only 3,600 for the cage system.

Additional Problems:

An increase in the number or "loss" eggs would cost the industry 2.2 ¢/dozen x 6 billion dozen eggs per year or \$132 million. This is attributable to the loss, destruction, and contamination of more eggs in the free-range system.

Additional feed consumption is estimated to cost another 2.2¢/dozen or \$132 million.

Additional medication to control internal and external parasites is expected to cost an additional 0.25 ¢/dozen or \$15 million for the free-range system. Cage operations do not have such problems.

Maintaining laying hens in strict adherence to the definition used for free-range management would not be possible in the Northern tier of states because of severe winter conditions. More than 200 million of the nation's 275 million layers (73%) are in 13 states that would be considered to have extremely cold winters and thus not suitable conditions for year-round free-range operations. This includes major egg-production states such as Iowa, Indiana, Ohio, Minnesota, and Nebraska.

Due to the variations in the price of land and the availability of laborers, certain states would have major advantages over others in producing eggs with the free-range system. Two thousand dollar per acre land is available in some regions while similar land in other regions may be ten times as expensive.

A-D. References:

1. Bell, D. D, 1997. When is it time to purchase new housing and equipment? Egg Economics Update No. 191, University of California newsletter, May 12, 1997.
2. Bell, D. D., and W. D. Weaver, Jr. 2002. Chapter 53, Management in Alternative Housing Systems *In: Commercial Chicken Meat and Egg Production*, Kluwer Academics.
3. Bell, D.D., and W.D. Weaver, Jr. 2002. Chapter 50, A Model One Million Hen In-Line Egg Production Complex, Kluwer Academics.
4. Bell, D.D. and W.D. Weaver, Jr. 2002. Chapter 52, Cage Management for Layers *In: Commercial Chicken Meat and Egg Production*, Kluwer Academics.
5. Cunningham, D. L., 2000. Broiler Production Systems in Georgia - Costs and Returns Analysis. University of Georgia, Misc. Publication.
6. Patterson, P. H., K. W. Koelkebeck, D. D. Bell, J. B. Carey, K. E. Anderson, and M. J. Darre, 2001. Egg Marketing in National Supermarkets: Specialty Eggs - Part 2. Poultry Science 80:390-395.

Don Bell, September 20, 2005

B. "The Council of the European Union: Council Directive 1999/74/EC of 19 July 1999 laying down minimum standards for the protection of laying hens."

Highlights of report by Don Bell, Poultry Specialist (Emeritus), University of California.

(This is a summary of the actual document. Go to the "web" for a complete copy.)

General considerations:

- (5) The protection of laying hens is a matter of Community competence.
- (7) The Commission - - - - concludes that the welfare conditions of hens kept in current battery cages and in other systems of rearing are inadequate and that certain of their needs cannot be met in such cages; the highest possible standards should therefore be introduced, in the light of various parameters to be considered in order to improve those conditions.
- (9) A balance must be kept between the various aspects to be taken into consideration, as regards both welfare and health, economic and social considerations, and also environmental impact.
- (10) It is appropriate, when studies on the welfare of laying hens in various systems are carried out, to adopt provisions that allow the Member States to choose the appropriate system or systems.

Article 1

- 1. This Directive lays down minimum standards for the protection of laying hens.
- 2. This Directive shall not apply to:
 - establishments with fewer than 350 laying hens.
 - establishments rearing (keeping) breeding laying hens.

Article 2

Definitions:

- (2a) “laying hens means: hens of the species *Gallus gallus* which have reached laying maturity and are kept for production of eggs not intended for hatching.
- (2b) “nest” means: a separate space for egg laying, the floor components of which may not include wire mesh that can come into contact with the birds, for an individual hen or for a group of hens (group nest).
- (2c) “litter” means: any friable material enabling the hens to satisfy their ethological needs.
- (2d) “usable area” means: an area at least 30 cm wide with a floor slope not exceeding 14°, with headroom of at least 45 cm (17.7 inches). Nesting areas shall not be regarded as usable areas.

(Note: additional definitions are provided in Directive 98/58/EC)

Provisions applicable to “alternative systems” (non-cage)

Member States shall ensure that from January 1, 2002 all newly built or rebuilt systems of production referred to in this chapter and all such systems of production brought into use for the first time

comply at least with the requirements below:

1. All systems must be equipped in such a way that all laying hens have:
 - a. Either linear feeders providing at least 10 cm (4.0 in.) per bird or circular feeders providing at least 4 cm (1.6 in.) per bird.
 - b. Either continuous drinking troughs providing 2.5 cm (1 in.) per hen or circular drinking troughs providing 1 cm (0.4 inches) per hen.
In addition, where nipple drinkers or cups are used, there shall be at least one drinker for every 10 hens. Where drinking points are plumbed in, at least two cups or nipple drinkers shall be within reach of each hen.
 - c. At least one nest for every seven hens. If group nests are used, there must be at least 1 m² (11.1 ft²) of nest space for a maximum of 120 hens.
 - d. Adequate perches, without sharp edges and providing at least 15 cm (6 in.) per hen. Perches must not be mounted above the litter and the horizontal distance between perches must be at least 30 cm (12 in.) and the horizontal distance between the perch and the wall must be at least 20 cm (8 in.).
 - e. At least 250 cm² (40 in²) of littered area per hen, the litter occupying at least one-third of the ground surface.
2. The floor of installations must be constructed so as to support adequately each of the forward-facing claws of each foot.
3. In addition to the provision laid down in points 1 and 2,
 - a. If systems of rearing are used where the laying hens can move freely between different levels,
 - i. There shall be no more than 4 levels
 - ii. The headroom between the levels must be at least 45 cm (18 inches)
 - iii. The drinking and feeding facilities must be distributed in such a way as to provide equal access for all hens
 - iv. The levels must be so arranged as to prevent droppings falling on the levels below
 - b. If laying hens have access to open runs:
 - i. There must be sufficient exit openings to provide 2 meters (6.7 feet) of openings for each 1,000 hens.
 - ii. Open runs must be “appropriate to the stocking density
4. The stocking density in alternative systems (not enriched cages) must provide 1 meter² for each 9 hens (172 in²). Allowances for up to 12 hens are made until 2012 if certain conditions

are met.

Provisions applicable to rearing in “unenriched” cage systems” (traditional cages)

All cage systems must comply with the following requirements from January 1, 2003

1. At least 550 cm² (85 in²) per hen of cage space for each laying hen.
2. At least 10 cm² (4 in²) of feet trough per hen
3. Continuous water trough comparable to the feeder. If nipple or cup waterers are used, there should be at least 2 drinkers available for each cage.
4. Cages must be at least 40 cm (15.7 in.) high over at least 65% of the cage area and not less than 35 cm (13.8 in.) at any point.
5. Floor slopes should be no greater than 14%
6. Cages should be fitted with suitable claw-shortening devices.

No traditional cages may be utilized after January 1, 2012. Furthermore, no new traditional cage houses may be build or brought into service for the first time after January 1, 2003

Provisions applicable to “enriched cages” (furnished or non-traditional cages)

Member States shall ensure that from January 1, 2002 all the cages referred to in this chapter comply at least with the requirements below:

1. Laying hens must have:
 - a. At least 750 cm² (116 in²) of cage area per hen, 600 cm² (93 in²) of which should be usable. No cage shall have less than 2000 cm² (310 in²).
 - b. A nest
 - c. Litter for pecking and scratching.
 - d. Perches allowing at least 15 cm per hen (6 in.)
2. At least 12 cm (4.7 in.) of feed trough per hen
3. Each cage must have a drinking system “appropriate” to the size of the group; where nipple or cup drinkers are provided, at least 2 waterers must be available to the birds.
4. Aisle space must be at least 90 cm (35 in.) wide. At least 35 cm (14 in.) of space must be allowed between the floor and the bottom tier of cages.
5. Cages must be fitted with claw-shortening devices.

General Requirements (Annex)

In addition to the relevant provisions of the Annex to Directive 98/58/EC, the following requirements apply:

1. All hens must be inspected at least once per day
2. The sound level shall be minimized
3. All buildings shall have sufficient levels of light. (more details are included in the full document)
4. Those parts of the building, equipment and utensils which are in contact with the hens shall be thoroughly cleaned and disinfected regularly and at depopulation. Droppings must be removed as often as necessary and dead hens must be removed every day.
5. Cages must be suitably equipped to prevent hens escaping.
6. Multiple tiered cages must have devices or appropriate measures to facilitate inspection and removal of hens.
7. The design and dimensions of the cage door should be such as to avoid suffering or injury to the birds.
8. In order to prevent pecking and cannibalism, authorization to beak trim may be given if carried out by qualified staff on chickens less than 10 days of age.

Comments:

Additional guidelines and definitions can be found in previous Directives – especially in “The Council of the European Union: Council Directive 1998/58/EC of 20 July 1998 concerning the protection of animals kept for farming purposes” (5 pages).

This earlier Directive (98/58/EC) includes general rules regarding:

1. Farm staffing
2. Inspection
3. Record keeping
4. Freedom of movement
5. Buildings and accommodations
6. Animals not kept in buildings
7. Automatic or mechanical equipment
8. Feed, water and other substances
9. Mutilations
10. Breeding procedures

**C. “Study on the socio-economic implications of the various systems to keep laying hens”.
Final Report for The European Commission. Submitted by Agra CEAS Consulting Ltd.**

December 2004

General Comments (highlights summarized by Don Bell)

- Traditional cages accounted for over 85% of egg farms in the EU-15 countries
- Traditional cages have substantial advantages in costs compared to non-cage systems due to lower labor, land and feed requirements.
- Limited data is available, but there's an indication that enriched cages (furnished cages) will not operate at a significant cost disadvantage to traditional cage systems.
- Their analysis indicates that free-range production is approximately 20% higher than in traditional cages; and that barn egg production is 12% higher.
- Traditional cages can no longer be built beginning January 1, 2003 and are banned from use starting January 1, 2012 (Germany has taken the initiative to ban traditional cage use beginning January 1, 2005 – 5 years earlier and on January 1, 2012, enriched (furnished) cages will also be banned
- The 25 countries of EU-25 produced 6.349 million MT of eggs in 2003. This is equivalent to approximately 390 million laying hens.
- The 15 countries (EU-15) produced 5.617 million MT of eggs in 2002 and 1.374 million MT were broken representing 24% of the total. Denmark, France and Italy each had 35% of their production as broken products.
- It is estimated that the use of alternate housing systems (non-cage) has risen from 3.56% in 1993 to 11.93% in 2003.
- Of the alternative systems, free-range shows the greatest percentage.
- Feed consumption between countries ranged from 109 to 120 grams/hen-day
- Eggs collected ranged from 261 to 293 per hen/year
- Mortality ranged from 4.0% to 7.5% per year.
- Hens to laborer ratio ranged from 10,000 to 50,000
- Feed requirements per bird (and feed conversion) are lowest in the traditional cage systems and highest in organic and free range systems. Generally, the more freedom a bird has to move about the more energy it needs. As bird density decreases, more energy will also be needed in order to keep warm. The number of eggs collected per bird per year is highest in the caged system and gets progressively lower through barn and free range to organic.
- The industry in most countries expects that demand for cheap eggs will remain and that the best way to service this demand will be through enriched cage production (where this is allowed by national legislation).
- Any additional costs are likely to be passed on to consumers in the form of higher price if there is sufficient border protection to stop imported third country shell eggs undercutting those produced in the EU-15.

D. “The European Food Safety Authority (EFSA) Journal (2005) 197, 1-23, The welfare aspects of various systems of keeping laying hens. Opinion of the Scientific Panel on Animal Health and Welfare on a request from the Commission related to the welfare aspects of various systems of keeping laying hens.” (24 pages)

Highlights of report by Don Bell, Poultry Specialist (Emeritus), University of California.

- EFSA was invited by the EU Commission to draw up an opinion on the welfare aspects of the various egg production systems described in Council Directive 1999/74/EC to include the safety of eggs for consumers
- It was considered outside of the scope of this opinion to consider ethical, socio-economic, cultural and religious aspects of the issue.
- A cage system is considered a system operated without human keepers entering it. This definition, therefore, includes the traditional cage as well as the so-called enriched cage or the furnished cage.
- Non-cage systems (not to be called alternative systems) represent all remaining forms (barns, aviaries, percheries, deep litter, and free range).
 - Three systems
 - Traditional (conventional) cages
 - Furnished cages (enriched)
 - Non-cage systems (alternative systems)
- It is generally accepted that when assessing the welfare of animals in different housing systems and attempting to come to overall conclusions, the most trustworthy method is by combining measures from different disciplines and different approaches.
- The problem of how different indicators should be weighted against each other to come to a final conclusion as to whether or not the housing system promotes good bird health and satisfies the behavioral priorities of the birds is difficult.
- Housing systems for hens differ in the possibilities for hens to show species-specific behaviors such as foraging, dust-bathing, perching and building or selecting a suitable nest. If hens can't perform such high priority behaviors, this may result in significant frustration, or deprivation or injury, which is detrimental to their welfare.
- Some of the most severe threats to bird welfare in the various systems are:
 - Conventional cages
 - Low bone strength and fractures sustained during depopulation (handling)
 - The inability to perform some high priority behaviors including nesting, perching, foraging and dust bathing.
 - Small furnished cages
 - Feather pecking and cannibalism in flocks with non-beak-trimmed birds.
 -

- Depending on lay-out (design), some high priority behaviors (e.g. foraging, dust-bathing) cannot be performed or are limited.
- Large furnished cages
 - No data is available on relevant issues like bone fractures, feather pecking and cannibalism.
- Non-cage systems
 - Bone fractures during lay
 - Feather pecking and cannibalism in flocks with non-beak-trimmed birds
 - If an outdoor run is provided for birds in non-cage systems, there is additionally a high risk of parasitic diseases.
- Beak trimming should be permitted only if significant amounts of injurious behavior would otherwise result.
- Keeping birds outdoors presents a risk of exposure to a greater range of infectious agents compared to birds kept only indoors. (includes wildlife, insects and bacteria).
- The level of downgraded (grade B, dirty, broken and cracked) eggs are reportedly higher in furnished cages and to a greater extent alternative systems when compared to traditional cage systems.
- Keeping birds outdoors presents a risk of exposure to a greater range of infectious agents - - - resulting in a different panorama of diseases.
- Flocks kept outside - - - (show increased infections with *Campylobacter* and internal parasites compared to cage systems).
- Levels of airborne dust, microorganisms, and ammonia levels in non-cage systems are usually higher than in cage systems.
- Mortality rates are often higher and less predictable in non-cage systems.
- Zootechnical parameters (e.g. water and feed consumption, egg production, egg shell quality, etc.) should be measured or monitored daily to alert producers to existing or impending welfare problems.
- Birds have a high behavioral priority to lay their eggs in a nest - - -.
- Drinking, feeding, foraging, and probably dust-bathing are high priority behaviors for laying hens.
- There have been no systematic studies carried out to establish the priority of preening, wing flapping and stretching.
- Resting and perching are important aspects of bird welfare.
- It is difficult to prescribe precise space allowances in non-cage systems due to the complexity of the environment and the ways birds distribute themselves.
- Behavioral repertoire is generally broader in non-cage systems
- There is a much greater risk of poor welfare due to injurious pecking and cannibalism in non-cage systems if birds are not beak trimmed.

Future Research Needs

First Priority Topics

- Health and Disease
 - New, effective and feasible treatment measures for the control of endo-and ecto-parasites
 - The risk of the spread of infectious agents by wild birds and rodents should be further assessed.
- Behavior and Systems Design
- Injurious Pecking and Cannibalism
 - Fundamental studies of the underlying cause for why particular birds start to show cannibalistic behavior would help improve our understanding (of this problem).
 - Studies should be carried out to investigate the possible link between cannibalistic behavior and commercially important traits.
- Foraging
 - Studies should be carried out to more clearly define availability, qualities and amounts of foraging facilities appropriate to good welfare.
- Comfort Behavior
 - Studies should be carried out to more clearly define the qualities (including feasible materials) and space allowances of facilities required to satisfy dust-bathing motivation
- Rearing
 - Research is needed on understanding the impact of how birds are reared on their ability to function well in different systems later in life.
- Design
 - Future research should focus on
 - Provision and use of litter and occupational devices
 - Space requirements, group size and stocking density.
 - Lighting

Other Relevant Topics

- Health and Disease
 - Research should be carried out on beneficial effects on health of access to an outside area.
 - More information is needed about the prevalence of old skeletal fractures in different layer systems.
 - Research is needed to examine the impact of depopulation (handling) procedures on skeletal fractures.

- Studies are required to establish the connection between feather pecking, cannibalism, cloacal pecking and infectious disease e.g. salpingitis.

➤ **Behavior and Systems Design**

- Egg Laying
 - More research is required on nesting motivation in social situations.
 - Studies should be carried out as to why hens do not lay in the nest when available.
- Comfort Behavior
 - More research is needed on dust-bathing issues
 - Further research is needed relative to the issues of preening, wing flapping and stretching.
- Perching
 - More research is needed on how chicks learn to use perches, and about perch design, location and positioning.
- Space, group size
 - Studies are needed to determine space vs. group size needs in furnished cage systems.
 - Motivational studies are needed for behaviors needing more than 116 sq. inches of space.
- Genetics
 - Criteria and methods should be identified and developed for genetic selection of birds that are better adapted to the various systems.
- Depopulation (handling)
 - A full evaluation of the effects of depopulation on bird fearfulness in the different systems is needed.
- Climate
 - Studies need to be conducted relative to temperature, dust, and ammonia in non-cage and furnished cage systems.
- Physiology
 - Further research is required in evaluating objective indicators such as antibody production and assays of corticosterone in feces and egg white.
- Beak Trimming
 - Research is required to determine the immediate and lasting pain due to various beak-trimming methods applied at different ages.

Food Safety Affected by Different Production Systems

- Microbiological Hazards
 - Research is needed to improve systems relative to egg quality and egg safety issues
 - Quantitative and Qualitative studies should be conducted on the microbiology of eggs produced in different housing systems. The effects of such microbial load and types of bacteria on the processing technology and quality of further processed products should be studied.

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E. “EU-25 Poultry and Products – Abolition of battery cages to cost 354 million Euros (428 million US dollars) to EU-25 egg producers”. USDA Foreign Agricultural Service GAIN Report No. E350065 dated March 31, 2005.

Report Highlights (as written)

“The EU ban on traditional cages for laying hens, which is scheduled for 2012, could cost European egg producers up to 354 million Euros (428 million US dollars) per year. A European Commission report calculates the cost of egg production indicating that switching to free range production increases cost by 20 percent and barn egg production increases cost by 12 percent. The European Food Safety Authority (EFSA) also recently opined that a marked increase in bacteriological, health and welfare problems should be expected.

Council directives 1999/74/EC, which was meant to improve physiological welfare of laying hens, appears to in fact increase animal health and food safety concerns at a huge economical cost to producers.

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F. “Will Germany Actually Ban Cages in 2007? H.W. Windhorst, University of Vechta, Vechta, Germany.”

(Highlights of report by Don Bell, Poultry Specialist (Emeritus), University of California.)

- Germany's current layer population is estimated to be 50 million whereas its human population is about 82 million.
- Germany is the 3rd largest table egg producing country in the EU-25
- They are the largest importer of shell eggs in the world with approximately 28% of world egg imports.

- In October 2001, the German Parliament passed the "Order for Laying Hen Husbandry" which states that
 - a. On January 1, 2007, conventional (traditional) cages will be prohibited – 5 years earlier than required of member states in the Directive 1999/74/EC of 19 July 1999 which applies to all EU-25 members.
 - b. On January 1, 2012, all enriched (furnished) cages will also be prohibited. No similar prohibition is currently included in EU-25 guidelines

- An egg producer initiative to modify the above directive to allow a 2-year extension of the use of cages and further study of alternative systems received a majority vote of the state representatives but failed to pass at higher levels of government.

- .By 2002, the number of hens kept in traditional cages reduced to 84%
- Sixteen percent were kept in alternative husbandry systems
- Free range showed the highest increase at 8.7% of the total
- Organic egg production was successful in the marketplace with egg prices at the consumer level at 3x the level of traditional cage eggs.

What will be the situation if the Directive in Germany of October 2001 will be altered because of new insights in the disadvantages of alternative husbandry systems with respect to:

- Higher mortality
- Disease problems
- Increasing risks for the introduction and dissemination of highly infectious diseases
- Egg quality
- Environmental problems from ammonia emissions and the contamination of the soil and groundwater.

Three scenarios of the effects of legislation on the German Egg Industry were studied. The following table summarizes the outcome of each.

Scenario 1 – EU directive (1999/74/EC) becomes effective

Scenario 2 – Banning of conventional cages from 2007 on

F-1. Effects of Various Legislation on the German Economy

Item	Before	Scenario #1	Scenario #2 (added to #1)	Scenario #3 (instead of #2)
laying flock on farms with 3000 or more (million hens)	40.8	35.7 (-13%)	19.6 (-45%)	28.9 (-19%)
Eggs produced (billion eggs)	11.4	9.9 (-13%)	5.0 (-45)	7.9 (-21%)
Value loss of primary egg industry (million Euros)		200	500	200
Value loss of associated industries (million Euros)		100	400	200
Loss of jobs		666	3200	1700
Added imports of eggs (billion eggs)		1.5 (5.6 billion eggs total imports)	4.9 (10.5 billion eggs total imports)	1.9 (7.5 billion eggs total imports)
Added investments (million Euros)		120	950	820

“At the present time, it is almost impossible to predict the future development of egg production in Germany. It will depend as well on the decision what is going to happen with the October 2001 Directive.” (Windhorst) which requires an earlier cessation of the use of standard cages in Germany and an elimination of the possible use of enriched cages in the future.

Germany is not the first to abolish the use of cages for the production of table eggs. Switzerland did it in 1991; Sweden followed in 1999 by abolishing the use of small non-enriched cages.

G-1. Summary of the Advantages of Cage and Non-cage Systems for Table Egg Layers *
Prepared by Don Bell, Poultry Specialist, (emeritus), University of California – October, 2005

Item	Reference source	Cage systems	Non-cage systems
Behavioral			
Nesting	D		High priority behavior
Dust bathing	D		High priority behavior
Foraging	D		High priority behavior
Perching	D		High priority behavior
Health	D	Lower risk of parasitic diseases	
	D	Less exposure to infectious disease agents	
Food Safety	D	Lower incidence of bacterial contamination of egg shells	
Performance			
Egg production	C, I-1	Highest number of eggs	
Feed consumption	C, I-1	Lowest and best feed conversion	
Mortality	D, I-1	Rates are generally lower and more predictable	
Egg quality	D	Lower incidence of down-graded eggs	
Economic			
Investment	I-A	Reduced investment	
Cost of Production	C I-A	Substantial advantage relative to costs	
Labor efficiency	I-A	Higher	
Egg prices	C, I-1		Higher values in current market conditions as specialty eggs.
Other	D	Fewer bone fractures	Higher bone strength and fewer

		during lay	fractures during handling
Air-borne dusts, micro-organisms and ammonia	D	Levels are usually lower	
Pecking and cannibalism	D	Less risk if birds are not beak trimmed	

* Based upon the sources listed in the two reference lists.

Other Differences Between Systems

In all systems, wide ranges of performance exists relative to perceived advantages and disadvantages. A cost advantage may prove to be a disadvantage for net profits. A high feed consumption rate may be offset by larger and more valuable eggs. Individual producers may have the ability to utilize a system more effectively than another.

Space allowances per bird obviously differ between systems – both floor space and vertical space. This has a bearing on the ability of the bird to move around, to practice various behavioral activities and to interact with her pen-mates. In addition, different systems are more conducive to controlling the environment in which the birds live which will favor one system over another. This was not discussed in the papers reviewed.

A much longer list than shown in Table G-1 can be claimed with added benefits to both system types.

The book “Commercial Chicken Meat and Egg Production” (A-D-4) lists the following differences between the two basic systems:

Advantages for Cages

- a) Easier to observe birds – no birds under foot (some multiple tier systems are very difficult to observe birds in higher tiers).
- b) Birds are separated from their feces thus providing a more sanitary environment
- c) Floor eggs are eliminated
- d) Eggs are cleaner
- e) Culling and handling of birds are expedited
- f) Chickens in cages consume less feed
- g) Broodiness is eliminated

Advantages for Non-Cage systems

- a) The investment per bird is usually lower (applies to deep litter and possibly free range operations)

- b) Manure handling may or may not be a problem depending upon the handling procedure
- c) Flies are usually less of a problem when the birds have access to the manure
- d) Eggs usually have less blood spots

H. General Tables - European Union

Table H-1. Major Table Egg Production Countries of Europe (EU-25) – 2003

Rank	Country	% of Total EU-25	Rank	Country	% of Total EU-25
1	Spain	17	6	Poland	7
2	France	15	7	Netherlands	6
3	Germany	12			
4	Italy	12			
5	UK	11		Other (18 countries)	20

Other EU-25 nations include: Austria, Belgium, Denmark, Finland, Ireland, Portugal, Sweden, Poland, Slovenia, Slovak Republic, Cyprus, Czech Republic, Estonia, Hungary, Lithuania, Latvia, and Malta.

Table H-2. Enriched (furnished) Cage Results – 2003 – Three countries only (limited data)*

Item	Belgium	Sweden	UK	Simple Average
Feed/hen/day (g)	111	115	115	113.7
Eggs/bird/year	285	238	274	265.7
Mortality (%)	4.0	5.4	4.0	4.5

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25

Hens/laborer	50,000	40,000	72,500	54,200
Hens/meter² of house	12	40	95	49
Space per hen (in²)	116	116	98	110

* Note: The authors did not consider these data to be sufficient to make any significant comparisons.

Table H-3. Netherlands Comparison of Traditional Cages, Enriched Cages and Aviary – 2005 *

Item	Cage 450 cm² (70 in²)	Cage 550 cm² (85 in²)	Enriched cages	Aviary
Investment/hen (\$)	22.32	27.23	37.39	32.43
Relative cost of production (%)	100	104	114	122

* Personal communications from the author – Peter van Horne, Poultry Economist, Wageningen University and Research Centre, The Netherlands.

Table H-4. Farm Characteristics - Major European Egg Producing Countries (2001-2003)

Item	France	Germany	Italy	Netherlands	Spain	Sweden	UK
Layer population (Millions)	49.1	50.0	54.0	28.7	45.8	5.5	30.0
Egg products *	35	25	35	25	10	20	20
Per capita egg consumption **	250	212	218	177	217	192	183
Hens/holding For (Number) above	23,300 (2100) (no defin)	70,035 (564) 10,000	56,174 (668) 10,000	37,886 (697) 10,000	96,428 (430) 30,000	24,669 (204) 5,000	79,672 (305) 20,000
Traditional cages (%)	83.7	84.0	96.5	75.0	99.0	16.0	69.0

1/11/2006

United Egg Producers Annual Mtg., Oct 2005

Free-range (%)	10.7	8.7		10.0	0.4		25.0 (includes organics)
Organic (%)	4.3		0.5		0.1	6.0	
Barn/aviary/perchery (%)	1.3	6.6	2.4	15.0	0.5	49.5	6.0
Enriched (%)						28.5	

* Source: Agra Ceas report* *Source: International Egg Commission (2003)

Table H-5. Characteristics by Egg Production System – EU 15 av. – (2001-2003)

Item	Traditional cage	Barn/aviary/Perchery	Free-range	Organic	U.S. Cages (estimated)
Feed/bird/day (g)	112	121	126	127	100
Eggs/hen/yr	280	269	261	246	270
Mortality/yr (%)	6.0	9.1	10.4	13.8	7.2
Hens/laborer	36,714	17,420	11,031	5,031	100,000
Hens/meter ² of house	79	8	8	7	45
Space per hen (in. ²)	83	197	193	224	54
Variable cost per dozen (\$)	0.54	0.61	0.67	1.17	0.32
Feed cost In ¢/dozen	0.38	0.42	0.46	.87	
Feed as a % of variable costs	70.4	68.9	68.7	74.4	
Fixed costs per dozen (\$)	0.22	0.33	0.45	.58	0.80
Total costs per dozen (\$)	0.76	0.94	1.11	1.75	0.40

Table H-6. Cost of Production Comparison Relative to Costs in Traditional Cages - % change

	Traditional cage	Barn/aviary/perchery	Free-range	Organic
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Total costs (\$/doz.)	0.76	0.94	1.11	1.75
% chge from cages	0	+24	+46	+130

Source: 1. Agra Ceas Consulting, Ltd.

Variable costs = feed, medication, bird depreciation, misc.

Fixed costs = labor, B & E costs, land, insurance, utilities, cleaning, misc. (interest costs not included)

Conversion rates: 1 Euro = \$1.21 US; 1 dozen eggs = .72 kilo

Note: US data was estimated by Don Bell for the 3-year period.

I. Sources of Information:

1. "Study on the socio-economic implications of the various systems to keep laying hens". Final Report for The European Commission. Submitted by Agra CEAS Consulting Ltd. December 2004. (112 pages)
2. "EU-25 Poultry and Products – Abolition of battery cages to cost 354 million Euros to EU-25 egg producers". USDA Foreign Agricultural Service GAIN Report No. E350065 dated March 31, 2005. (7 pages)
3. "The Council of the European Union: Council Directive 1998/58/EC of 20 July 1998 concerning the protection of animals kept for farming purposes" (5 pages).
4. "The Council of the European Union: Council Directive 1999/74/EC of 19 July 1999 laying down minimum standards for the protection of laying hens" (4 pages).
5. "The European Food Safety Authority (EFSA) Journal (2005) 197, 1-23, The welfare aspects of various systems of keeping laying hens. Opinion of the Scientific Panel on Animal Health and Welfare on a request from the Commission related to the welfare aspects of various systems of keeping laying hens." (24 pages)
6. Annex to item 4 above "Scientific Report – Welfare aspects of various systems for keeping laying hens". Adopted by the Panel on Animal Health and Welfare (AHAW) on September 14/15, 2004. (143 pages)
7. "Will Germany Actually Ban Cages in 2007? H.W. Windhorst, University of Vechta, Vechta, Germany. (12 pages)

Prepared by Don Bell, Poultry Specialist (emeritus), University of California, Riverside
28

8. “Economic Perspective of Different Housing Systems for Layers”, Peter van Horne, Poultry Economist, Wageningen University, Netherlands, 2005