Impacts of Improved Animal Welfare Standards on Competitiveness of EU Animal Production

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Abstract

The paper presents results of the FP7 Econ-Welfare Project "Assessing the socio-economic consequences of measures promoting good animal welfare". The paper illustrates the economic consequences at the farm level of indicative improvements in animal welfare conditions for pigs and cattle and addresses the consequences of improved animal welfare for international trade and competitiveness[1]. For the farm level considerations costs - effectiveness analysis was applied, whilst impacts of the upgraded standards on international trade and competitiveness was assessed with the use of the partial equilibrium Agmemod model. The Belief Network Approach was used to determine the effects of animal welfare standards and labels on the competitiveness of the EU animal production and supply chain.

Introducing upgraded Animal Welfare standards at the farm level would increase costs of production in pigs and beef cattle sectors. In dairy sector upgrading cows welfare standards results with higher benefits than costs. Accordingly, Agmemod results indicate that on the pork and beef markets international competitive position of the EU producers may be undermined. However, as the analysis showed, there are both supply conditions and demand side circumstances which may well resolve the apparent conflict between animal welfare and chain competitiveness. On the supply side, it is apparent that there are some animal welfare improvements that can be made without compromising competitiveness. Supply chain information, education and training may well be able to improve both animal welfare and competitiveness. In addition, better understanding of both animal welfare and animal productivity (through R&D) can be expected to lead to improvements in both objectives.

Keywords: *animal welfare, upgraded standards, cost and benefits, Agmemod, trade implications, competitiveness, chain.*

1 Introduction

Socio-economic evolution of markets and associated government and governance has progressively explored the possibilities of increasing animal productivity. With existing knowledge and techniques, farm businesses could be both more and more productive. The process of intensification and concentration of animal production seems to be continuing [Mench 2008]. However, consumers are becoming more and more conscious about food quality and safety. Societies become richer, better educated and more able and willing to

[1] Impacts of upgrading Animal Welfare standards in the poultry sector were also assessed in the EconWelfare project, however results are not presented in this paper due to complexity of animal welfare issues in poultry production.

take care of their environments and activities, so they tend to be more willing to pay for improved animal welfare [Tsakiridou et al.2010, den Ouden et al. 1997].

Animal welfare issues have risen up the public debate agenda due to a growing political and social interest, which has resulted in increased policy attention. In the European Union the first animal welfare requirements were formulated in a legal directive in the nineties [Council Directives 1991, 1993, 1998]. Animal welfare has been taken into account by the most recent EU policies, and is reflected in the Strategy for the Protection and Welfare of animals 2011–2015, which continues of the EU Action Plan on Animal Welfare 2006-2010. Animal Welfare is increasingly gaining importance for today's societies [Horgan, Gavinelli 2006]. A policy reflection of this trend is a continued discussion at the level of the European Commission and in the EU member states about upgrading animal welfare standards above the current legislated level. Several countries like for example Sweden, Great Britain and Germany have already legislated national reforms in this area [Berg, Hammarström 2006, Ferrari P*. et al* 2010]. The legislation establishing enforceable minimum standards for livestock welfare coexists with a number of private animal welfare standards and initiatives that regulate different aspects of animal husbandry on farm, during transport, and at slaughter (Schmid et al 2010). Private standards formulate animal welfare requirements that often go above the minimum welfare standards as imposed by the different EU regulations.

A potential conflict exists between society's preferences regarding animal welfare and interests of the producers [Toma et al., 2008], creating a challenge to balance both points of view. Complex studies on Animal Welfare economics and implications of imposing AW standards for the farming sector as well as for the entire food chain have not been presented in the literature before, but several studies on particular markets show increased costs of production ranging from 5% to 50% [Appelby 2003, Tweeten 2009, Bornett et al. 2002]. Quantifiable financial benefits are also reported in some cases (Lawrence 2009, Corazzin 2010). Another important issue regarding improving animal welfare through government regulations is their impact on international trade [Frank 2002, Fraser 2008, Grethe 2007] and competitive position of the EU livestock farms and food producers on the global market.

There is an undoubted public desire for improved standards of farm animal welfare, but unfortunately not fully matched with an increased demand due to limited willingness of consumers to pay for high welfare standard products [Tawse 2010, Pouta et. al 2010]. Already announced or likely attempts of further changes in the EU legislation on Animal Welfare that may introduce upgraded standards requiring from farmers to change the animal husbandry practices raises the questions of what the financial implications for the farming sector in the EU countries will be, as well as the impacts on international trade.

Consequences of imposing upgraded animal welfare standards in selected sectors (pigs and cattle) are discussed at the farm, EU production and international trade levels. For the farm level considerations costs - effectiveness analysis was applied, whilst impacts of the upgraded standards on international trade and competitiveness was assessed with the use of the partial equilibrium Agmemod model. Authors examine it in a context of implications for competitiveness. The Belief Network Approach was additionally used to determine the effects of animal welfare standards and labels on the competitiveness of the EU animal production and supply chain.

2 Farm level implications of upgraded AW standards

2.1 Methodology of the analysis

The cost-effectiveness analysis (CEA) approach was used to estimate the financial consequences of upgrading Animal Welfare standards at the farm level. In the analysis "benefits" were identified and quantified as positive factors (effects) which add financial value to revenues from an activity, whilst "costs" represent additional costs (negatives) associated with a course of alternative actions. Quantitative analysis of financial impacts at the farm level was performed on the basis of a number of case studies reflecting the selected livestock sectors in Europe: dairy cows, beef & veal cattle, pigs.

For all case studies the upgraded standards were constructed based on the animal welfare initiatives from different European countries as identified within the EconWelfare project. These countries were Poland, Spain, UK, Sweden, Italy, FYR Macedonia, The Netherlands and Germany.

Upgraded Animal Welfare standards

For each of the case studies considered in the cost/effectiveness analyses, upgraded animal welfare standards that introduce specific requirements above the existing EU regulations were constructed. Standards are composed of "norms" that relate to different aspects of animal husbandry. For constructing standards only those norms were chosen which are measurable, are more restrictive or more precisely defined than existing EU regulations and result in apparent and quantifiable positive effects and/or additional inputs and costs. Potential norms, even if important for providing better animal welfare, were omitted if they had negligible costs and/or benefits. 2010 was the baseline year for comparisons with livestock keeping systems based on upgraded Animal Welfare standards.

Two levels of standards were identified:

- **"Moderate"** - less restrictive and considered applicable for large scale operations and more likely to be adopted by a greater number of commercial farms;

- **"Premium"** - more restrictive, largely based on standards for organic production and most likely applicable to small size herds of livestock and less commonly adopted throughout the sector.

The standards, subject to further impact assessment are presented in tables 1-2.

For the purpose of the Cost/Effectiveness Analysis a spreadsheet model was constructed. The partial budgeting model calculates net gain or loss in revenues for an average farm assuming existing animal welfare standards are replaced with the upgraded standard (consisting of the specific sets of norms identified above). For calculations the following assumptions were made:

- each of the upgraded norms in the model refers to a common practice (specific animal husbandry practices: the most typical for the livestock farming in a country);
- for all norms constituting standards, estimates of potential benefits and/or inputs, required by the new norms compared with current practice were made by the experts on animal husbandry and/or animal welfare. These estimates are supported by results of research in specific areas, practical knowledge and expert judgment in some cases, where scientific evidence could not be provided;

- the percentage of livestock kept on farms which don't already comply with the new requirements was estimated (for each single norm) based on the expert's knowledge of the farming practice in the country.

Apart of the assumptions listed above there were other technological and economic parameters of the model provided by partners from countries represented in the project. There were several sources of parameters used - statistical, normative and farm survey data. There were six areas distinguished in which upgrading animal welfare standards may result with increased revenues or savings on costs (benefits) or, the opposite, may cause reduction of revenues or increase of costs of production (costs): veterinary costs, labour input, mortality of animals, feed requirements, productivity (yield or price change), investments required to comply with upgraded welfare standards. Calculation of costs and benefits included any direct investment cost (eg. replacing slatted floors, establishing outdoor area, installing enriched cages for hens, etc.) counted in the model at the value of annual depreciation of investment in these fixed assets.

Farm level modelling results were further aggregated to the country scale for each of the species. To be able to do so, it was assumed that the new ‘higher welfare’ situation in a country would mean that 80% of farmers will introduce "Moderate" standard and the remaining 20% the "Premium" standard. Estimates of the number of farms already complying with the requirements of upgraded standards are taken into account in the aggregation procedure. Thus, the aggregated results (total net costs or benefits for the sector, per average farm and per unit of production) reflect the implications of introducing upgraded standards for those farms which would need to change animal husbandry practices according to assumptions made on the percentage of compliance with upgrades for individual norms within standards.

All the results are net values (additional costs minus potential benefits) relative to the base year 2010.

Table 1. Upgraded Animal Welfare standards for fattening pigs and sows

Norms - Fattening Pigs	**EU regulation – baseline**	**Standard - Moderate**	**Standard - Premium**
Allowance of roughage	Not regulated	Roughage (straw) added to the daily ration	Fresh or dried fodder, or silage added to the daily ration
Facilities to avoid competition for feed	Not regulated	33cm per fattening pig	
Bedding materials in laying area on farm	Not regulated	Lying areas must be sufficiently covered with straw	
Avoidance or limitation of slatted floors	Slatted floors allowed with no limits	50% of the indoor surface area shall be solid	100% of the indoor surface area shall be solid
Lightening on farm	Pigs must be kept in light with an intensity of at least 40 lux for at least 8 hours/day	Ratio Floor: Window must be 15:1, additional electric lightening, at least 50 lux	
Space allowance (indoor)	>30 up to 50 kg – 0,40m2; >50 up to 85 kg – 0,55m2; >85 up to 110 kg – 0,65m2; >110 kg - 1m2	>30 up to 50 kg – 0.52 m2; >50 up to 85 kg – 0.72 m2; >85 up to 110 kg – 0.85 m2; >110 kg - 1,3 m2	>30 up to 50 kg – 0.8 m2; >50 up to 85 kg – 1.1 m2; >85 up to 110 kg – 1.3 m2; >110 kg - 2 m2
Access to outdoor run on farm	Not regulated	Not required (not feasible for large scale)	>30 up to 50 kg – 0.6 m2; >50 up to 85 kg – 0.8 m2; >85 up to 110 kg – 1 m2; >110 kg - 1.2 m2 (outdoor)
Norms - Sows and piglets	**EU regulation – baseline**	**Standard - Moderate**	**Standard - Premium**
Minimum age at weaning	28 days	42 days	49 days
Bedding materials in laying area on farm	Not regulated	Lying areas must be sufficiently covered with straw	Lying areas must be sufficiently covered with straw
Avoidance or limitation of slatted floors	Not regulated	57% of the indoor surface area shall be solid	100% of the indoor surface area shall be solid
Lightening on farm	Pigs must be kept in light with an intensity of at least 40 lux for at least 8 hours/day	Light intensity at least 50 lux Ratio Floor: Window must be 15:1	Light intensity at least 60 lux, Ratio Floor: Window must be 20:1
Space allowance on farm + access to outdoor run	The total unobstructed floor area available to each gilt after service and to each sow when gilts and/or sows are kept in groups must be at least 1,64 m2 and 2,25 m2 respectively.	Farrowing pen for sow and piglets at least 5 m2. Pregnant sows grouped indoor at least 2.40 m2 in barn and 1.25 m2 in outdoor run.	Pens for sow with piglets <40 days: at least 7.5m2 indoor + 2.5m2 outdoor. Pens for pregnant sow: 2.5m2 indoor + 1.9m2 outdoor
Breeding (avoidance of fast growing/hyper muscled breeds)	Not regulated	No breeds that cannot give birth to their offspring in a natural way.	Preferred robust and resistant races and crosses. Not allowed are races susceptible to stress.
Avoidance of tooth clipping/grinding	Allowed	Tooth grinding rather than tooth clipping	Not permitted
Avoidance of castration	Allowed	Castration of male animals only with anaesthesia	Not permitted
Avoidance of tail docking	Allowed	Allowed with vet approval only	Not permitted

Table 2. Upgraded Animal Welfare standard for dairy cows and beef cattle(*Source: own calculations)*

Norms - Dairy cows	**EU regulation – baseline**	**Standard - Moderate**	**Standard - Premium**
Allowance of roughage on farm	Not regulated	At least 50% of the dry matter in the daily ration must be roughage	At least 60% of the dry matter in the daily ration must be roughage
Natural milk for young calves	Not regulated	Natural milk for at least 3 days following the birth must be provided	Natural milk for at least 5 days following the birth must be provided
Bedding materials in laying area	Not regulated	Ample dry bedding strewn with litter material shall be provided in the rest area.	
Avoidance or limitation of slatted floors	Not regulated	No fully slatted floors, max. 50% of total area.	Completely forbidden.
Air quality in buildings (toxic gases, dust)	not harmful to the animals	Inhalable dust and ammonia levels should not exceed 10 mg/m3 and 25 ppm respectively. Building ventilation must aim to achieve a relative humidity below 80% when ambient conditions allow.	
Avoidance of tethering - small scale farms	Not regulated	Tethering allowed when cows have an access to pasture	No tethering only open run systems.
Space allowance on farm with open run system	Space must not be restricted in such a way as to cause suffering or injury of animals	-	Dairy cow 6m2 indoor +4.5m2 outdoor
Access to pasture	Not regulated	Grazing during whole growing season	
Norms – Beef & veal cattle	**EU regulation – baseline**	**Standard - Moderate**	**Standard - Premium**
Allowance of roughage	Not regulated	At least 50% of the dry matter in the daily ration must be roughage.	At least 60% of the dry matter in the daily ration must be roughage.
Bedding materials in laying area	Appropriate bedding must be provided for all calves less than two weeks old	Ample dry bedding strewn with litter material shall be provided in the rest area.	
Avoidance or limitation of slatted floors	Not regulated	Max. 50% of total area as slatted floors allowed	Slatted floors completely forbidden.
Air quality in buildings	not harmful to the animals	Inhalable dust should not exceed 10 mg/m3, ammonia levels should not exceed 25 ppm. Building ventilation must aim to achieve a relative humidity below 80% when ambient conditions allow.	
Avoidance of tethering (<1 year)	Calves shall not be tethered, with the exception of group-housed calves - may be tethered for not more than 1 hour	No tethering only open run systems	
Limitation of tethering- cattle > than 1 year	Allowed	Allowed	Forbidden
Space allowance	1,5 m2/calf - live weight < 150 kg; at least 1,7 m2/calf - live weight of 150 kg - 220 kg; at least 1,8 m2/calf with a live weight > 220 kg.	Unobstructed floor area: Cattle (-100kg) 1.5m2 indoor + 1.1m2 outdoor; (-200kg) 2.5m2 indoor + 1.9m2 outdoor; (-350kg) 4m2 indoor + 3m2 outdoor; (350kg+) 5m2, min.1m2/100kg indoor + 2.5m2, min. 0.75m2/100kg outdoor.	
Outdoor run or pasture - cattle < 1 year	Not regulated	An outdoor run and feeding with fresh forage	Grazing during whole growing season
Outdoor run or pasture - cattle > 1 year	Not regulated	An outdoor run and feeding with fresh forage	Outdoor run and feeding with fresh forage

2.2 Cost/Effectiveness Analysis - farm results

Impacts of the defined, upgraded animal welfare standards on financial results at the farm level differ between species as well as between countries.

The results show that the most affected species are **pigs,** both fattening pigs and sows (figures 1 and 2). In all case studies additional costs significantly exceed potential benefits resulting with an increase of direct costs of production, thus potentially reducing farm incomes of pig farmers. Net cost increase in pig farms was generated mainly due to additional requirements such as roughage in the diet, avoidance of slatted floor, more space allowance and outdoor run. This applies to both the Moderate and Premium standards. The most costly norms in the upgraded standards (except density reductions) have a relatively high potential to generate benefits (which are allowed for in these net cost estimates). Thus, lowering the requirements would not significantly change the net Cost/Effectiveness Analysis results.

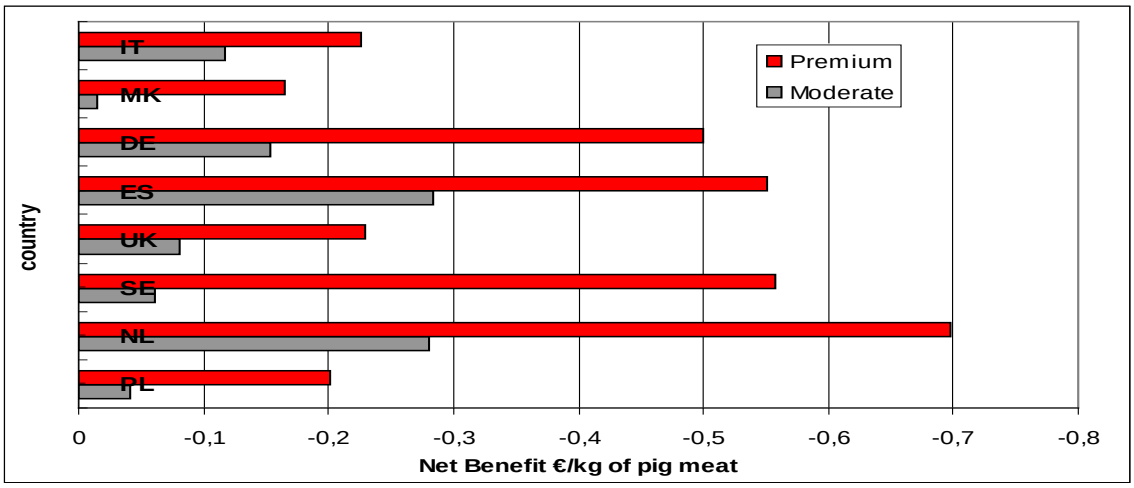

Figure 1. Farm level Net benefit or cost of upgrading Animal Welfare - fattening pigs
Source: deliverable of Econwelfare project

Cost of keeping sows change with the similar pattern (fig. 2), although the relative impact per country differs.

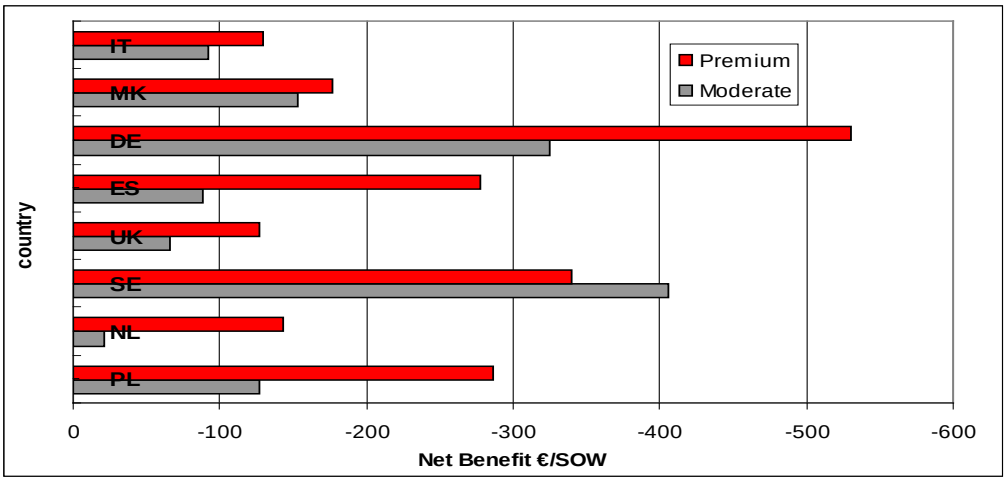

Figure 2. Farm level Net benefit of upgrading Animal Welfare standards for sows
Source: deliverable of Econwelfare project

Implementing the "Premium" standard always generates higher net additional cost compared with the "Moderate". Improvement of animal welfare in the more restrictive standard for pigs is more costly and does not generate sufficient benefits to compensate the costs.

Adopting upgraded standard for Fattening Pigs would generate additional costs in all countries represented in the project. However there are noticeable differences in the level of additional costs between countries. This is largely due to significant differences between countries in labour costs and prices of other inputs, that explain to some extent a divergence in final results of the cost/effectiveness analyses. In some countries (mainly the UK) existing animal welfare standards are already relatively high, thus adjustments to upgraded standards generate lower additional costs.

Financial impacts of upgrading AW standards in **beef & veal** production were not substantial although a net additional cost is generated in the model (fig. 3). The main reason for this is that in the upgraded standards there are no significant restrictions on density of cattle so that these higher standards, as reflected in our chosen norms, do not generate substantially higher costs, though do offer some benefits in terms of increased productivity.

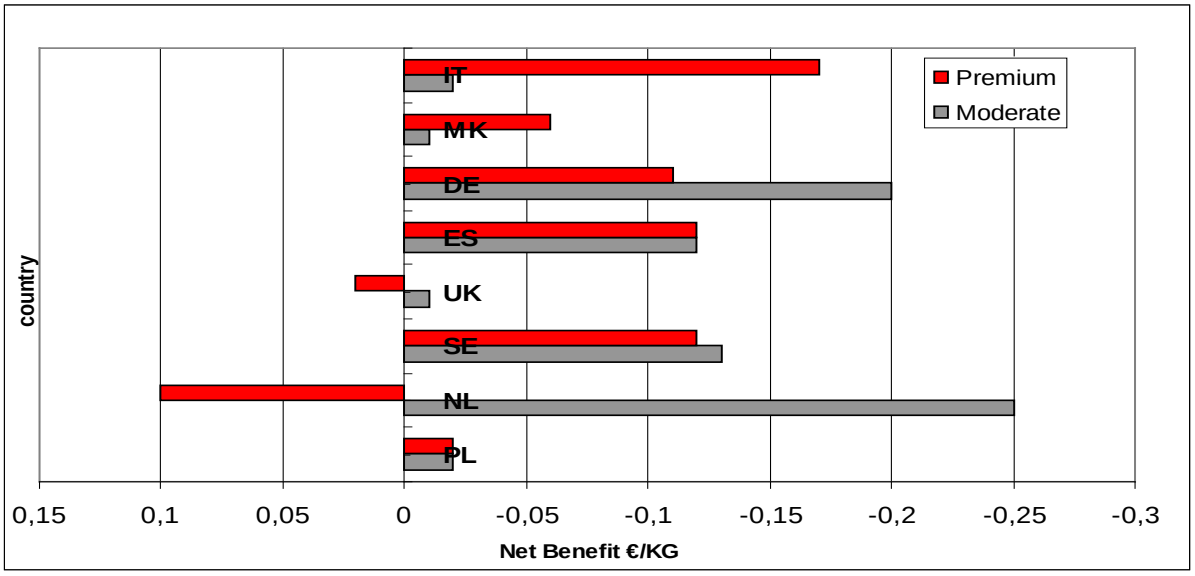

Figure 3. Farm level Net benefit of upgrading Animal Welfare standards for beef & veal cattle
Source: deliverable of Econwelfare project

In the **dairy cow** sector existing EU and national regulations seem to achieve a relatively high standard of animal welfare and there were no major improvements possible for the constructed animal welfare standard. Moreover, some of the requirements introduced in the upgraded standard have a high potential of generating benefits (eg. increased access of dairy cows to pasture allows for a higher milk yields and/or reduced culling).

Animal Welfare upgrades introduced to dairy farms for cows result in small net benefits (fig. 4).

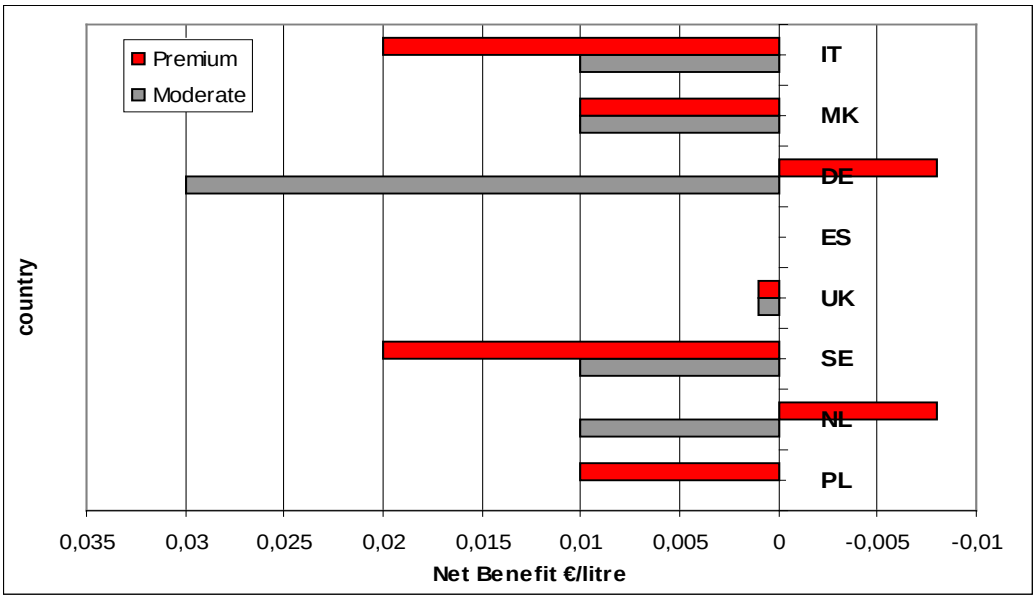

Figure 4. Farm level Net benefit of upgrading Animal Welfare standards - dairy cows
Source: deliverable of Econwelfare project

2.3 Costs and Benefits - aggregated sector results

The modelling results were aggregated to the sector (country) scale under our basic assumption that 80% of farmers will introduce the Moderate standard, and the remaining 20% will adopt the Premium. The final outcome of the aggregation is calculated as a weighted average for all standards considered, taking into account proportions of animals kept in different systems and estimated share of farms that already comply with the requirements of the upgraded standards.

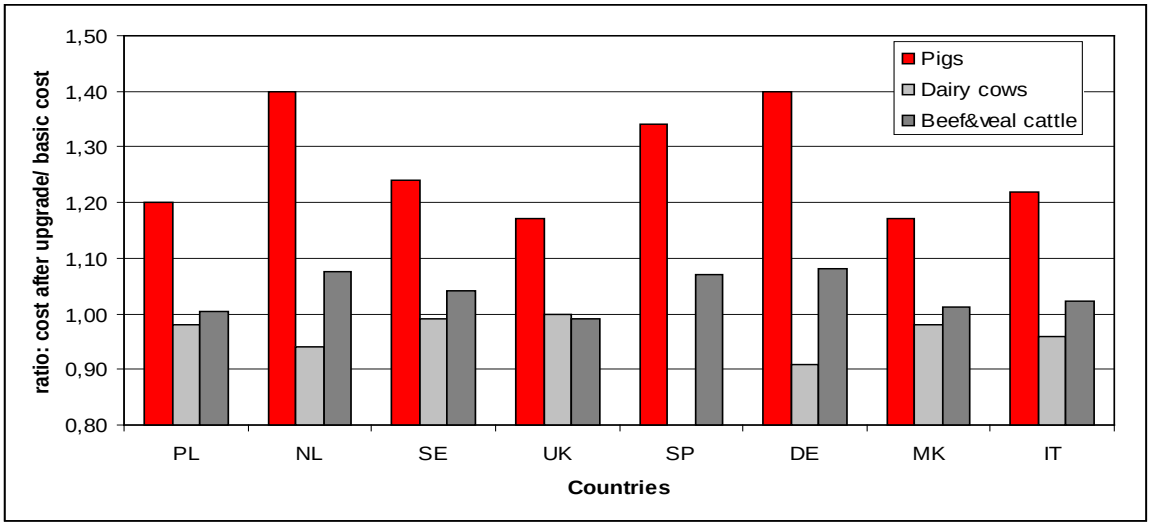

Figure 5. Cost change ratio after introducing upgraded standards.
Source: own calculations

Figure 5. illustrates the total effect expressed as the ratio of average total costs of production after upgrade (for each country), to the average total costs of production in the base year 2010. The cost increases include both additional variable costs and also additional

fixed costs per unit of production associated with any density reductions required by the upgraded standards (mainly for pigs).

In the table 4 an increase of prices needed to compensate additional costs of upgrading animal welfare standard are presented.

Table 4. Price increases [%] necessary to compensate costs of upgrading animal welfare standards (related to prices from the year 2010)

Species	PL	NL	SE	UK	SP	DE	MK	IT
PIGS	18,39%	36,21%	21,85%	15,03%	30,46%	36,32%	15,47%	19,60%
COWS	-0,20%	-0,38%	-0,25%	-0,12%	x	-4,25%	-0,19%	-0,92%
BEEF CATTLE	0,46%	7,60%	4,04%	0,09%	6,92%	8,14%	1,23%	2,22%

Source: own calculations

2.4 Conclusions from cost/effectiveness analysis

Introducing upgraded Animal Welfare standards to a level where 80% of farms comply with a 'Moderate' increase and 20% with a 'Premium' increase will result in an increased costs of production on farm in all species considered, except dairy cows.

Dairy farms benefit from introduction of upgraded standards due to a high potential to generate benefits (mainly milk yield increase) and/or costs reductions. According to the farm level analysis, we would expect some of these improvements to be adopted over time, even if nothing else changes, since they would apparently improve productivity. This result seems to imply that the dairy sector is somewhat less competitive at the farm level than the other sectors – since otherwise we would expect that these improvements would already be widely adopted. It may be that the extent and nature of CAP support and protection for the dairy sector has limited the competitive pressures.

The most affected are pigs because of requirements such as use of roughage in the diet, avoidance of slatted floors, space allowance (also causing density reduction) and outdoor run. In the countries which already have a high level of animal welfare standards (the UK, Sweden) net costs of upgrading standards are relatively lower.

Maintaining the economic viability of the primary sector in the face of such improved standards depends largely on the ability of markets (consumers' willingness to pay) to compensate for the additional costs of upgrading Animal Welfare standards. If the EU unilaterally introduces upgraded standards and costs are not compensated, the competitive position of the EU livestock sectors on the international markets may be undermined.

3 Agmemod Model of EU Agriculture - consequences for production and international trade

Based on the results of the farm level cost/effectiveness analysis the consequences of the associated cost changes on EU production, consumption and self-sufficiency levels (changes in net-trade positions) by country were assessed with the use of the Agmemod[2] model.

The Agmemod is a model of EU agriculture and food demand which uses a set of econometric equations to simulate production and consumption (and hence net trade) in each of the EU member states for each of the major agricultural commodities, including animal products. The Agmemod model works as a system of aggregated local models and is able to produce forecasts and scenario analyses of various policy and external conditions' changes for the Member States separately as well as for the entire EU (Donnellan et. all 2002; Chantreuil and Hanrahan 2007). The work in the project was inaugurated in 2001 by the institutions representing the Old Member States (OMS) and resulted in a coherent system of models able to produce the aggregated forecasts for the EU-15 (Chantreuil and Hanrahan 2007). In the subsequent years, the project was extended to the EU's New Member States.

Each particular country model consists of a set of sub-models of the main agricultural products: grains, oilseeds and the derived products, industrial plants, milk and dairy products, livestock and meat as well as some other less important and more locally grown products. The variables entering in each sub-model represent consecutive positions in the supply/demand balance sheet of each market. On the supply side the beginning stocks, production and imports are included, and on the demand side domestic use, exports and ending stock are modelled. The respective domestic prices are modelled for each product in each country, and also for the whole EU (where the EU price is treated as the key price).

Country market models are solved independently, nevertheless the behaviour of supply and demand variables in each member state market model is driven by a common key price for this particular product. For each market included in the AGMEMOD model, the key price is the price of the product in the country which is its most important producer in the EU. In most cases, the country price of a given commodity depends on a simultaneous development of the key price, lagged domestic and EU (or key country) self-sufficiency rates and other variables. The determinants of key prices include the respective world prices (which are exogenous in the model), the EU self sufficiency rate, the EU intervention prices and other variables important for the behaviour of key market prices (e.g. exchange rates, tariff rates, quota limits and subsidized export limits) (Chantreuil, Tabeau, van Leeuwen 2008; Esposti and Camaioni 2007).

The EU net export variable is used as the closing variable at the EU level, with net exports being adjusted to ensure EU equilibrium prices. The necessary solution condition for the model is the equality between supply and demand in each market (including net trade as the balance between exports and imports) in each country must hold.

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[2] Agmemod is an acronym of the name of the project: **Ag**riculture **Me**mber States **Mod**eling, constructed within the 5th and 6th EU Framework Project in cooperation with several European research institutes (Agmemod, 2005). This research was supported by EU FP6 research funding, contract SSPE-CT-2005-021543, by contributions from the partners' institutes throughout the EU and through associated projects for the Institute for Prospective and Technological Studies (IPTS). The authors acknowledge the work of the AGMEMOD Partners in the development of the model used for this study. http://www.agmemod.eu/."

3.1 Agmemod Model Results

In the Agmemod model changes in animal welfare standards were represented as changes in the costs of production. In case of dairy production milk yields (productivity) change was also introduced into the model. For those EU member states not participating in the EconWelfare project, for which no independent assessments of the changes in costs were modelled at the farm level, it was assumed that their cost changes are the same as those estimated for similar participating countries (table 3). To simulate effects of introducing upgraded AW standards, the Agmemod equations for total costs (cost index) as well as milk yield were modified. The impacts of improving welfare standards were calculated by comparison with the baseline scenario (that is considered to be continuation of the current system). All results presented here are made for the year 2020.

Table 3. Changes of the costs of production and milk yields used in Agmemod simulations (scenario)

Country	Pig meat costs change [%]	Beef & veal costs change [%]	Milk costs change [%]	Milk yields change [%]
AT	40.36	8.24	-9.36	2.8
BE	40.36	8.24	-9.36	2.8
BG	17.19	1.31	-2.34	1.07
CZ	20.44	0.55	-2.47	1.07
DE	40.36	8.24	-9.36	2.8
DK	20.18	1.75	-0.85	0.47
EE	20.44	0.55	-2.47	1.07
SP	33.84	7.2	-4.2	1.42
FI	20.18	1.75	-0.85	0.47
FR	31.18	7.12	-6.78	2.11
GR	17.19	1.31	-2.34	1.07
HU	20.44	0.55	-2.47	1.07
IE	16.22	-0.83	-0.17	0.02
IT	22	2.3	-4.2	1.42
LT	20.44	0.55	-2.47	1.07
LV	20.44	0.55	-2.47	1.07
NL	40.15	5.41	-6.09	0.56
PL	20.44	0.55	-2.47	1.07
PT	33.84	7.2	-4.2	1.42
RO	17.19	1.31	-2.34	1.07
SE	24.15	4.32	-1.52	0.92
SI	20.44	0.55	-2.47	1.07
SK	20.44	0.55	-2.47	1.07
UK	16.22	-0.83	-0.17	0.02

Source: own calculations based on Econwelfare project.

Figures 7 – 9 show the percentage changes in production and self-sufficiency in each country (except for milk, where the changes are in production and deliveries to dairies) generated by the Agmemod model, as a result of changing average costs of production and milk yield in each member state according to table 5. In general, the model's supply response to increase production costs is to reduce production, which results in an increase in market prices. Consumer response to rising prices is a decrease in consumption. However, due to the low price elasticity of demand the consumption decline is relatively small compared to changes in production.

Each country's market equilibrium is achieved through the supply/disposition balance, with price-linkage equations which relate price in each member state to the self-sufficiency ratio (production divided by domestic use) in each member state, to the previous year's market price and some other exogenous variables such as exchange rates, tariff rates, the EU's intervention prices for the commodity and the world price for the commodity. These linkage equations represent the price relationships between each member state market and the rest of the EU and the world market (Salamon, 2008). In addition, price reactions are damped by world prices, which are taken as exogenous in the Agmemod model, so the effects of changed EU production levels on world prices is largely ignored in this model.

As Figures 7– 9 illustrate there is no simple correspondence between the costs changes in each member state and the consequences for self-sufficiency ratios (or domestic production in the case of dairy). The consequences depend on, *inter alia*, the relative changes in domestic (member state) costs, relative to both other commodities within each member state and their substitutability or complementarity with each other on both the supply and demand sides of the market, and also on the relative changes between member states and with the rest of the world. The specific effects depend on a complex way on these relationships within the Agmemod model, and also (of course, and probably somewhat differently) in the real world.

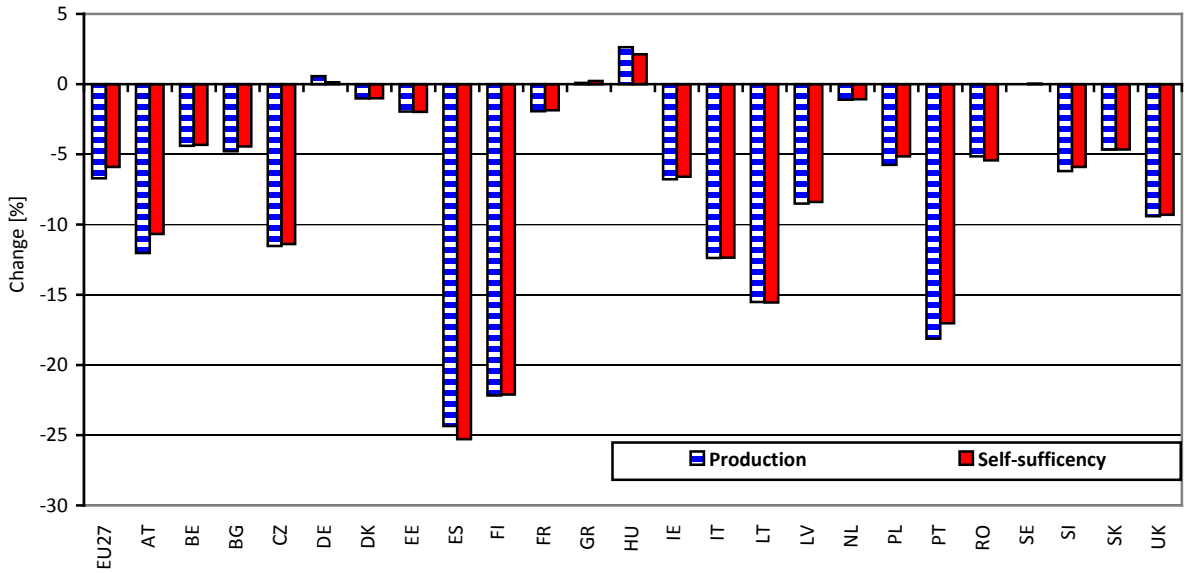

Figure 7. Agmemod results for a pig market
Source: own calculations.

For instance, a relatively high increase in pork production costs compared to small raise in the cost of beef production may cause changes in consumer preferences. As a result in some countries production and consumption of beef and veal could not decrease according to the simple cost/price relation. An even stronger relationship exists between production of milk and production of beef and veal.

The **pig market** is most affected by improving animal welfare standards in the European Union (Figure 7) in this model, as would be expected since the cost increases associated with the improved standards are estimated to be greatest in this sector (table 5). Simulations indicate that pig meat production in the EU27 in 2020 would decrease by 6.7% in comparison to the baseline as a result of upgrading animal welfare standards.

Lowering of supply will directly affect pork prices. According to the Agmemod simulation market price would increase by 2.1% in Germany (key price) and by 2.7% in the EU27 on average. Buyer reaction on higher prices would reduce pig meat consumption by 0.4% in the model. As a result of changes of production and consumption self-sufficiency in would be lower by 5.9%. The most negatively affected countries would be Spain and Finland. In these countries self-sufficiency decreases by more than 20%.

The impact of upgrading standard on **beef and veal** market is less significant and more diversified than in case of pig market (Figure 8). There is an estimated decrease in production of 0.52%. Self-sufficiency reductions are smaller (0.32%) as a result of a marginal (0.20%) decrease in beef and veal consumption. Upgrading animal welfare standards will cause an increase of market prices of beef and veal. Increases in EU countries range between 0.5% to 2.5%.

The strongest decrease of production, according to Agmemod simulations, is in Portugal (over 3.8%) and is negatively correlated with substantial increase of costs of production. On the other side the most noticeable positive impact of changes of the welfare standards would be in Austria where increase of production and self-sufficiency is over 2.5%. The increase in beef and veal production and improvement net trade position in Austria results from A substantial decrease in costs of production of milk (over 9%) coupled with a 2.8% increase in milk yields, which increases both milk production and dairy cow numbers, which in turn increase beef and veal production.

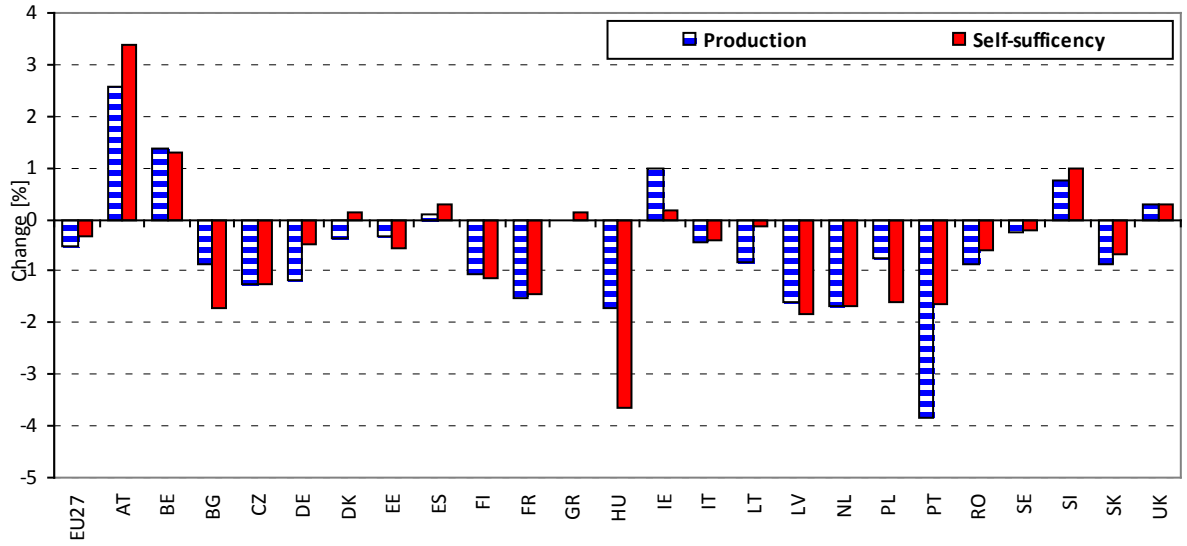

Figure 8. Agmemod results for a beef and veal market
Source: own calculations.

Simulated changes in Agmemod **milk production** are strongly correlated with changes of costs adopted in the model. Milk production is increased most in Belgium and Austria, respectively: 6.05 and 5.39%. In these countries the costs are estimated to decrease by 9.36%. Also, the positive impact the raising of standards takes place in the major milk producers in the EU (Germany and France). Among the countries in which, according to Agmemod simulations, we have to deal with the largest decrease in production (approximately 2%) are Latvia, the Netherlands, the UK and Lithuania (Figure 9).

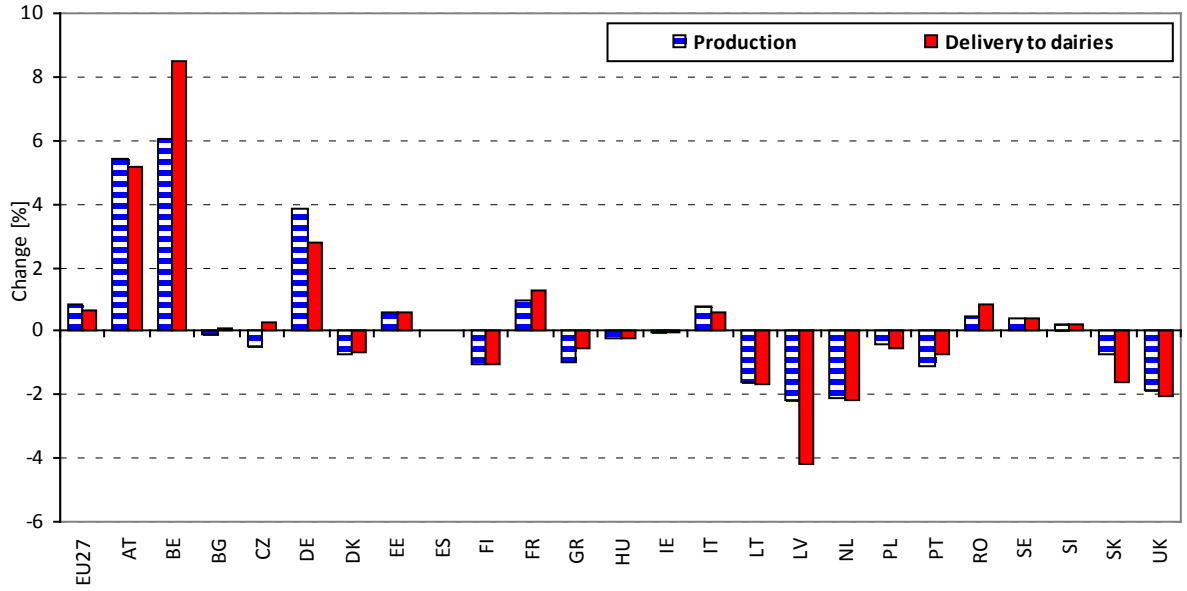

Figure 9. Agmemod results for a raw milk market
Source: own calculations.

Given estimated changes in net benefits resulting from the higher standards (Table 4), milk production in the European Union is estimated in Agmemod to increase by 0.82%, and deliveries to dairies by 0.67%. The increase in market supply is reflected in lower prices of

milk delivered to dairies. The simulated drop in the key price is 4.5%, while the arithmetic mean of price declines in individual countries is 3.0%.

Price reductions should lead to increased consumption of dairy products in particular countries of EU27. For example, the simulated increase in the consumption of butter is 1.24% and the consumption of cheese – 0.67%. This translates directly to changes in foreign trade dairy products. The simulated impact of upgrading of animal welfare standards on dairy product net trade positions varies both between countries and products. For example the self-sufficiency ratio for the EU27 declines in case of butter by 0.5% and increases for cheese market by 0.66%.

4 A Belief Network Approach

Belief networks (BNs) provide consistent semantics for representing uncertainty and an intuitive graphical representation of the interactions between various causes and effects. As a consequence, they are proving to be a very effective method of modelling uncertain situations that depend, or at least are assumed to depend, on cause and effect. Belief networks are especially useful when the information about the past and/or the current situation is vague, incomplete, conflicting, and uncertain.

BNs are compact networks of probabilities that capture the probabilistic relationship between variables, including historical information about their relationships. They are very effective for modelling situations where some information is already known and incoming data is uncertain or partially unavailable (unlike rule-based or "expert" systems or decision trees, where uncertain or unavailable data results in ineffective or inaccurate reasoning). BBNs (also known as Bayesian networks, Bayes networks and causal probabilistic networks), provide a method to represent relationships between propositions or variables, even if the relationships involve uncertainty, unpredictability or imprecision.

4.1 An outline BBN for European Animal Welfare.

Based on the lessons learned from the previous studies within econwelfare project it is possible to outline a BBN for the EU's Animal Welfare system as shown below (Figure 10). Here, we have outlined an 'alpha' version of a possible BBN representation of the priorities and apparent but implicit linkages between the objectives and instruments for improving AW. The 'alpha' version needs to be considered and amended by Stakeholders prior to eliciting their beliefs about the current states of the variables, and hence the implicit outcomes. Once the general structure (variable ('node') definition and directional relationships ('edges') between then) is established, the 'beta' model can be populated with expert (stakeholder) judgements about the current state of the system as represented by the network. This elicitation can be done electronically with a relatively simple Delphi-like survey of stakeholders for their beliefs about the current states of each of the variables (nodes). The system then amalgamates the stakeholders' beliefs forming a system which is then capable of manipulation and exploration.

At the centre of the belief network is *LABELING*, the effectiveness of which depends on the underlying *STANDARDS*, which may be weak or strong. Although this particular instrument (Labelling) does not score especially highly in the Delphi survey, it does seem to be the fulcrum through which the other preferred instruments (standards) are likely to have their effects on the priority objectives. The strength of the standards depends on 3 key factors, as

identified here: the *Chain Education, R&D, and TRUST in PUBLIC ADMIN*, since the administration and implementation of standards clearly affects the strength of standard application. *Trust in Public Admin*, in turn, depends on *Public Education*. The effectiveness of *Labeling* also depends on *TRUST in MARKETS*, which also depends on the extent of *Public Education*, since the effectiveness of labels requires people to trust their provenance. Given well-informed and well implemented labels, backed up with strong standards, EU ANIMAL WELFARE then depends also on *PUBLIC AWARENESS*, conditioned by the *SOCIO-ECONOMIC CULTURE*, where, a priori, richer countries might be expected to be more aware of animal welfare as an issue, and be willing to do something about it, than poorer countries.

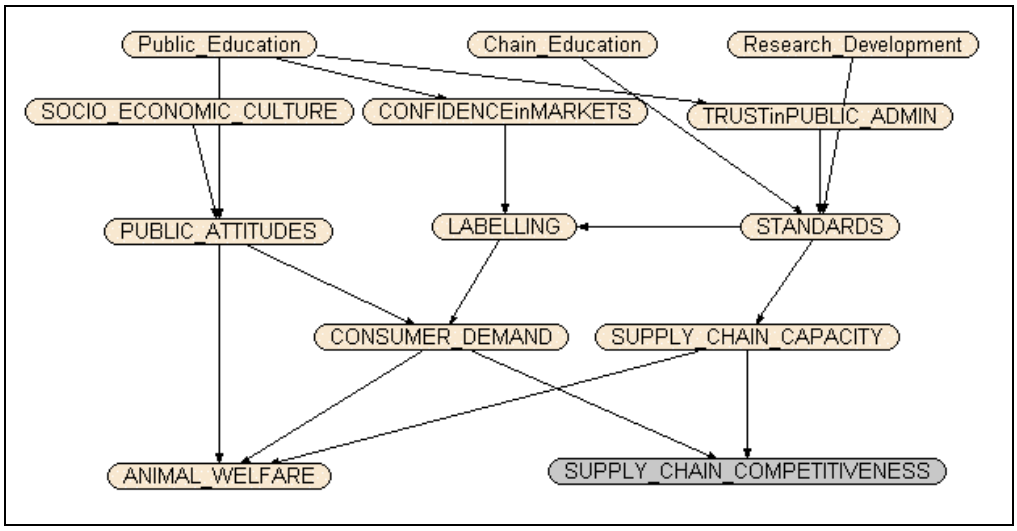

Figure 10. Econ Welfare Belief Network ('alpha' version**).**

Added to the variables are the *Willingness to Pay* (WTP) for AW (*CONSUMER DEMAND*) and the *Willingness to Comply* (SUPPLY CHAIN CAPACITY) variables. WTP is a demand-side measure of the extent to which consumers are willing to support improved animal welfare though paying a premium (as necessary) for high standard, labelled, products. *Supply Chain Capacity* is a supply-side measure of the extent to which the supply chain, including farmers, has both the capacity and the willingness to provide better AW, and is expected to be greater the lower the net costs (greater the net benefit) of ensuring improved AW. These two variables combine to determine the effects of animal welfare standards and labels on the competitiveness of the EU animal production and supply chain (SUPPLY CHAIN COMPETITIVENESS).

Step 2 in the implementation of this approach requires the major stakeholders to 'sign-off' on the general structure – generating the 'beta' model. Stage 3 then involves surveying all the stakeholders (i.e. those responding to the Delphi) for their judgments of the state of the current system to generate a 'gamma' model which will operational in the sense that it can be used to analyse and explore the consequences of changes. At least in principle, this systematic representation can be operationalised to explore the possibility and extent of a major trade-off between improved EU animal welfare the competitiveness of the EU animal chain. This approach also provides a mechanism through which the effects of changes in the state of these key variables can be explored – as an aid to further discussions and negotiations about future strategy and policy.

4.3 BBN Data Collection & Network Calibration

Data collection for the Econ Welfare Bayesian Belief Network follows the classical (theoretical) stages outlined above. Based mainly on findings within the Econwelfare project, a BBN 'alpha' model was created by researchers at Newcastle University using Netica (Norsys) software. This model was then presented to a number of stakeholders (NGOs, industry, academics and farmers representatives) who were asked to consider and amend, according to their animal welfare expertise and beliefs, the general structure of the model and the direction of causality (edges) between the nodes.

After all comments were incorporated, a 'beta' model was circulated to all partners and sent to those previously responding to the Delphi survey. Experts were asked to provide as many 'cases' (collections of node ratings) as possible, and for each case to 'score' according to their judgement and beliefs the state of the current animal welfare system in their country, region or sector. Each node included four 'states' with a score between 1 and 4 (e.g. for labelling: very effective = '1', effective = '2', ineffective = '3' and very ineffective = '4'). 82 cases across the eight countries were received by the end of June 2011.

Our 'trained' version of the Belief Network is shown in Figure 11. Each variable (node) box shows the proportion of our total sample of cases (82) answering with each score. In each case, apart from the bottom left hand node (ANIMAL WELFARE), the 4-scale scores have been contracted to 2-scale by aggregated the very good/good to the 'good' score and the poor/very poor scores to the 'poor' score. However, our respondents provided judgements about the present conditions of animal welfare in the EU which were highly skewed towards the good/very good end of the spectrum (a notable result in itself), as shown in Figure 12, with only 7% of our responses recording present animal welfare as poor or very poor. As a consequence, the trained network showed very little response of animal welfare to changes in any of the presumed 'drivers' in this case. However, re-calibrating the network to consider only the very good response (17.3%) in the animal welfare node as 'good', and treating all other responses (82.7%) as 'poor' allows some indicative response patterns to be identified.

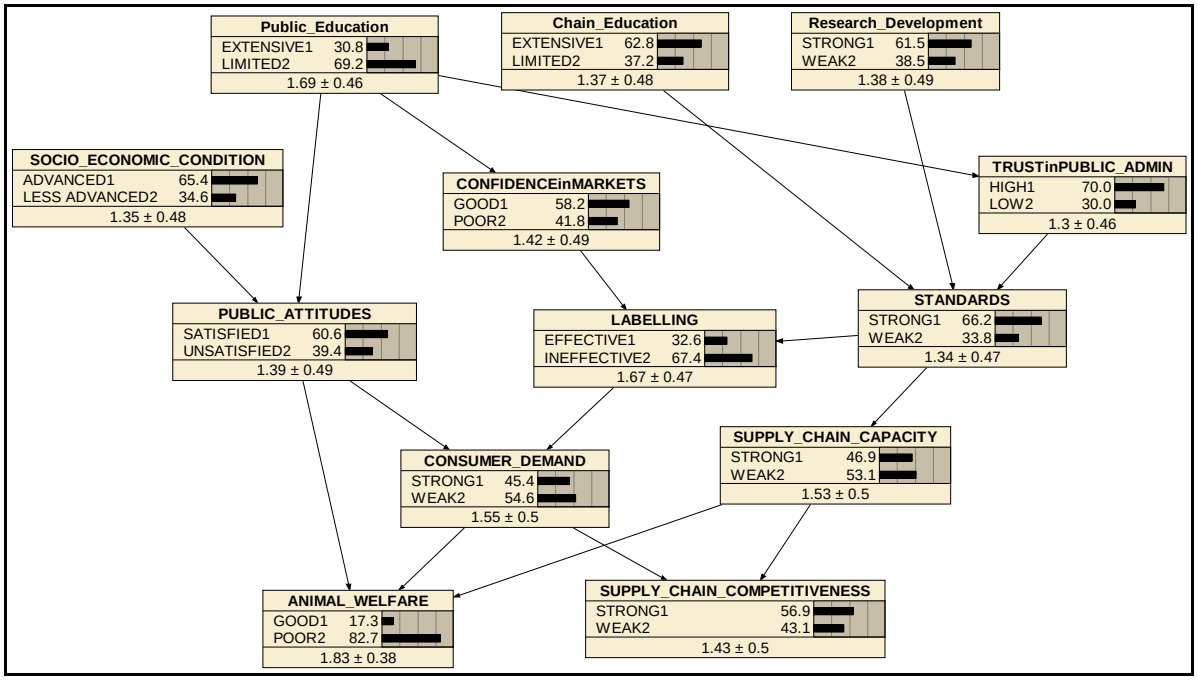

Figure 11. Econ Welfare Belief Network ('trained'/calibrated version).

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Figure 12. Beliefs about Current Animal Welfare and Supply Chain Competitiveness in the EU

The bi-value distribution of our respondents judgements on the current state of the variables driving animal welfare and supply chain competitiveness are shown in Figure 12, with slightly more (57%) considering that the supply chain is currently reasonably strong compared with 43% who consider it weak (or very weak). It is also notable that our respondents tend to judge labelling and public education weak rather than strong, 67.4% and 69.2% respectively, while they are more satisfied with the current states of chain education, R&D, trust in public administration, standards and public attitudes (63%, 61.5%, 70%, 66.2% and 65.4% respectively considering these to be good/high rather than poor/low).

5 Belief Implications for Improving Animal Welfare

Given these beliefs about the current state of the 'animal welfare system' in Europe, it is possible to explore the consequences of improvements in the major drivers for both animal welfare and chain competitiveness. Figure 13 shows the consequences of improving the state of public education from 31% good to 100% good.

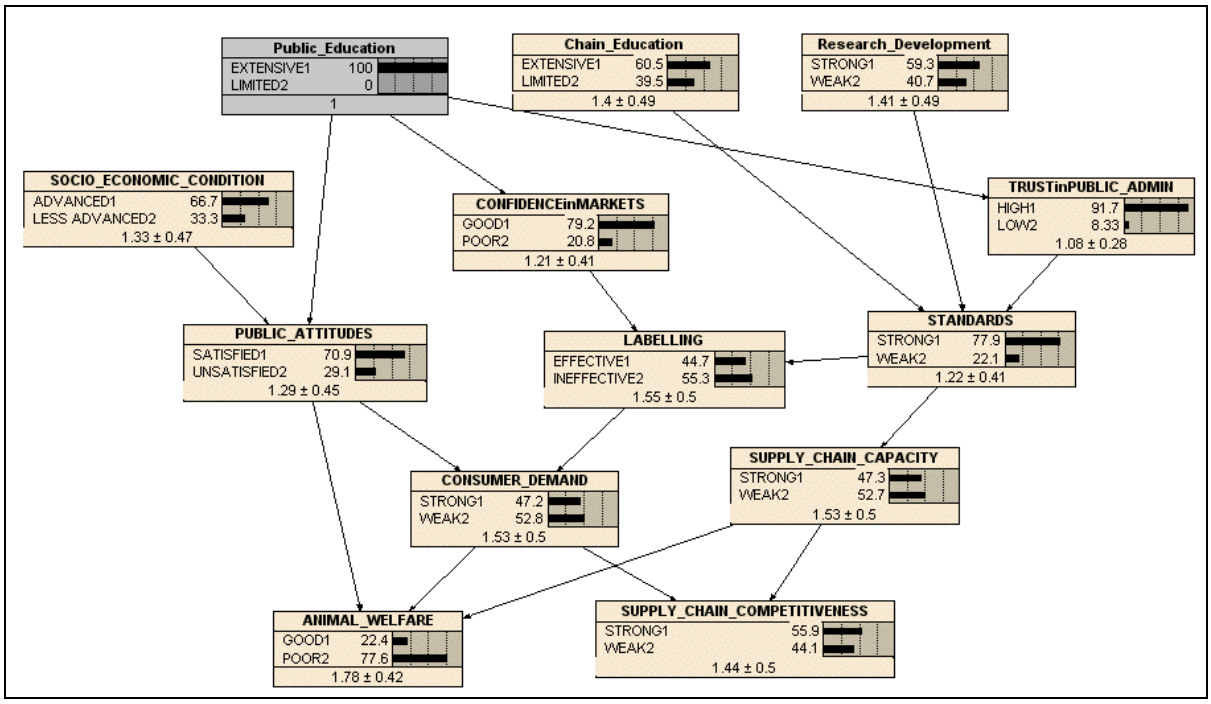

Figure 13. Improving Public Education.

According to the beliefs of our respondents, this improvement would increase animal welfare from 17.3% good to 22.4% good (Figure 13 cf. Figure 10), and very slightly (insignificantly) weaken competitiveness from 57% to 56%. This consequence follows from the effects of public education on public attitudes, confidence in markets and trust in public administration, which in turn improve consumer demand, standards and labelling and supply chain capacity.

Similarly, the implications of improving market demand (independently of other variables) from 45.4% strong to 100% strong. If this could be achieved, the consequence would be both an improvement in animal welfare (17.3% to 24.4% good) and in supply chain competitiveness (from 56.9% to 58.6% strong). The implications, according to this belief network, are that the determinants of market demand, especially the effectiveness of labelling and the strength of standards, would also need to improve, from 32.6% to 37.9% effective and from 66.2% to 67.9% strong respectively.

Figure 14 shows the consequences of improving standards from 66% to 100% strong, other things being equal. Again, this would improve animal welfare, from 17.3% to 20.2% good, and marginally improve supply chain competitiveness from 56.9% to 57.6% strong. These consequences follow from improvements in labelling effectiveness (from 32.6% to 42.5%) and thus in consumer demand (from 45.4% strong to 46.6% strong).

The implications of this pattern of beliefs (noting the caveat that we do not have sufficient beliefs to calibrate (train) this network robustly) are that improving animal welfare does not need to compromise supply chain competitiveness, despite the simple economic analysis, which apparently suggests that the twin objectives will generally be conflicting. However, as Figure 14 illustrates, the belief that the objectives are in conflict is also apparent in this network.

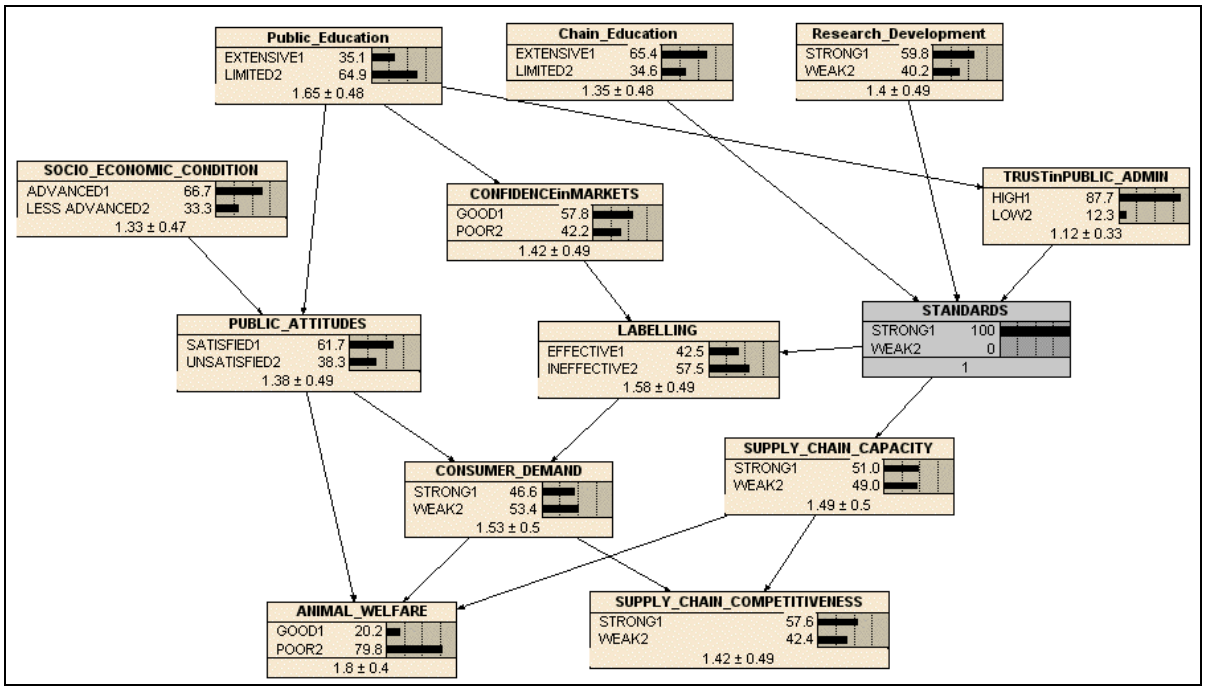

Figure 14. Improving strength of standards

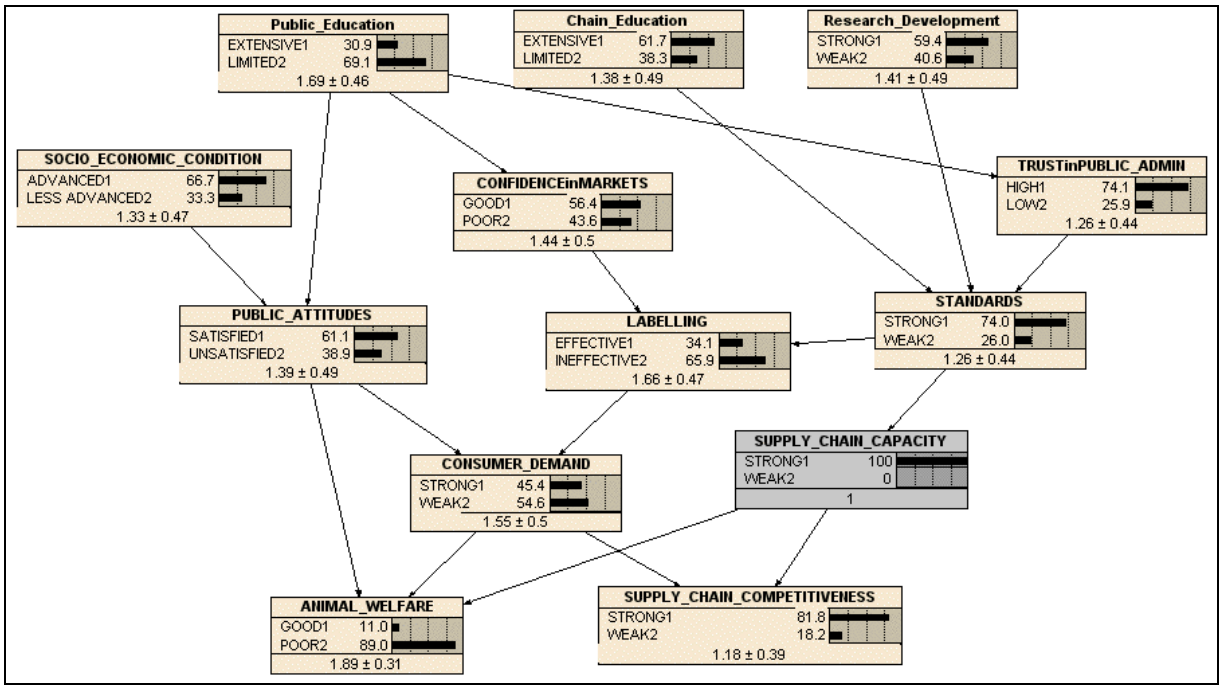

Figure 15. Improving Supply Chain Capacity

Simply improving supply chain capacity according to this belief network reduces animal welfare from 17.3% to 11%, while improving competitiveness from 56.9% to 81.8%. This belief pattern apparently reflects the 'vicious circle' of animal welfare– that increased competition tends to harm animals as businesses strive to make money – rather than the 'virtuous circle' where more intelligent businesses pay attention to both actual and potential

consumer and citizen demands, as well as more able producers learning that improved animal welfare can also be more productive, or at least no less productive.

6 Conclusions

The simple economic analysis of the consequences of improving animal welfare on international trade and supply chain competitiveness implies that the twin objectives are likely to be in conflict. Improving animal welfare, in otherwise competitive markets, would be supposed to increase the costs of producing animal products, which (other things being equal) will reduce competitiveness of the producers relative to their international competitors (and, as far as consumers are concerned) relative to other goods and services.

However, as our simulation analysis shows, there are both supply conditions and demand side circumstances which may well resolve the apparent conflict between animal welfare and chain competitiveness. On the supply side, it is apparent that there are animal welfare improvements that can be made without compromising competitiveness at all – rather the opposite in the case of dairy according to our characterisation of potential improved standards. Not everyone is doing as well as they could (industry best practice), so supply chain information, education and training may well be able to improve both animal welfare and competitiveness. In addition, better understanding of both animal welfare and animal productivity (through R&D) can be expected to lead to improvements in both objectives.

On the demand side, it is clear that at least some people are both interested in and willing to support improved animal welfare, both by supporting animal welfare advocacy groups and by seeking out animal welfare friendly products and supply chains. The proportion of the total population who are more kindly disposed towards farmed animal welfare is also likely to increase both with income and with public education. Provision of more reliable labels (or incorporation of improved animal welfare standards within more general brands and trademarks), backed with verifiable standards, will re-inforce and extend the ‘market’ for improved animal welfare.

It is also clear that conditions and circumstances change over time – societies develop and evolve. These complex dynamics have not been examined in this paper, and indeed there are no substantive analytical frameworks that are capable of dealing with this complexity. However, it is apparent from the history of animal welfare in Europe that societies do become more aware of and concerned about animal welfare over time (as they become better off, more secure, better educated and informed). As they do so, producers, suppliers and retailers become more aware of and responsive to both citizen and consumer demands for better treatment of animals. The processes of governed market competition become more focused on both resolving the simple conflict between animal welfare and commercial survival (competitiveness) and harmonising private initiatives with market regulation and public support.

References

Appelby M.C. (2003). The European union ban on conventional cages for laying hens: history and prospects. J. Appl. Anim. Welf. Sci. 2003, nr 6(2):103-121

AGMEMOD Partnership (2005). Impact analysis of the CAP reform on main agricultural commodities. Final Report. European Commission Directorate General JRC – IPTS.

Bornett H. L. I., Guy J. H., Cain P. J. (2002). Impact of animal welfare on costs and viability of pig production in the UK. J. Agri. Environmental Ethics, 2002, 16: 163-186.

Conforti P. (2001). The Common Agricultural Policy in main Partial Equilibrium models. Osservatorio sulle Politiche Agricole dell'UE, INEA, Working Paper No. 8.

Chantreuil F., Hanrahan K. (2007). AGMEMOD EU Argicultural Market Outlook. Drustvo Agrarnih Ekonomistov Slovenije, DAES.

Chantreuil F., Donnellan T., van Leeuwen M., Salamon P., Tabeau A., Bartova L. (2008). EU dairy quota reform – AGMEMOD scenario analysis. XIIth Congress of the European Association of Agricultural Economists, Ghent, Belgium.

Chantreuil F., Tabeau A., Van Leeuwen M. (2008). Estimation of impact of EU agricultural policies on the world market prices. Modeling of Agricultural and Rural Development Policies. Sevilla, 107th EAAE Seminar "Modelling of Agricultural and Rural Development Policies". Sevilla, Spain.

Corazzin M., Piasentier E., Dovier S., Bovolenta S. (2010). Effect of summer grazing on welfare of dairy cows reared in mountain tie-stall barns Ital. J. Anim. Sci. vol. 9(59), p. 304-312

COUNCIL DIRECTIVE 98/58/EC of 20 July 1998 concerning the protection of animals kept for farming purposes (OJ L 221, 8.8.1998, p. 23), amended by Council Regulation (EC) No 806/2003 of 14 April 2003 (OJ L 122, p.1, 16.5.2003).

COUNCIL DIRECTIVE of 19 November 1991 laying down minimum standards for the protection of calves (91/629/EEC) (OJ L 340, 11.12.1991, p. 28), amended by: Council Directive 2008/119/EC of 18 December 2008 laying down minimum standards for the protection of calves (OJ L 10, 15.1.2009, p. 7–13)

COUNCIL DIRECTIVE of 19 November 1991 laying down minimum standards for the protection of pigs (91/630/EEC) (OJ L 340, 11.12.1991, p. 33), amended by: Council Directive 2001/88/EC of 23 October 2001 (OJ L 316, p.1, 1.12.2001), Commission Directive 2001/93/EC of 9 November 2001 (OJ L 316, p.36, 1.12.2001), Council Regulation (EC) No 806/2003 of 14 April 2003 (OJ L 122, p.1, 16.5.2003); Council Directive 2008/120/EC of 18 December 2008 laying down minimum standards for the protection of pigs Official Journal L 47, 18/02/2009 p. 5

COUNCIL DIRECTIVE 93/119/EC of 22 December 1993 on the protection of animals at the time of slaughter or killing (OJ L 340, 31.12.1993, p. 21) amended by Council Regulation (EC) No 806/2003 of 14 April 2003 (OJ L 122, p.1, 16.5.2003); Council Regulation (EC) No 1099/2009 of 24 September 2009 on the protection of animals at the time of killing;

Den Ouden m., nijsing J.T., Dijkhuizen A.A., Huirne R.B.M. (1997). Livestock production Science 1997, 48: 23-37.

Donnellan T., Hanrahan K., McQuinn K., Riordan B. (2002). Policy analysis with AG-MEMOD Model: Dealing with diversity in the EU Agri-Food Sector. RERC, Paper prepared for presentation at the EAAE Congres 2002.

Esposti R., Camaioni B. (2007). Technical Report on the Modeling Structure, AGMEMOD WP2 D2, Project no. SSPE-CT-2005-021543.

Ferrari P., De Roest K., and others (2010) Report on (dis) advantages of current animal welfare standards for animals, based on the main findings of EU and national research projects. Deliverable 2.3 of Econwelfare Project. 01.2010

Frank J. M. (2002). the actual and potential Contribution of economics to animal welfare issues. Society and Animals, 2002, 10:4, 421-428.

Fraser D. (2008).Toward a global perspective on farm animal welfare. Appl. Anim. Behav. Sci. 2008, 113: 330-339.

Grethe H. (2007). High animal welfare standards in EU and international trade- How to prevent potential 'low animal welfare havens'? Food Policy, 2007, 32:315-333.

Horgan R., Gavinelli A. (2006). The expanding role of animal welfare within EU legislation and beyond. Livestock Science, 2006, 103:303-307.

Lawrence A.B. (Alistair W. Stott) (2009). Profiting from animal welfare: an animal-based perspective. Scottish Agricultural College The Oxford Farming Conference 2009

Marcot, B.G., Steventon, J.D., Sutherland, D.G. and McCann, R.K, 2006, "Guidelines for developing and updating Bayesian Belief Networks applied to ecological modeling and conservation", Canadian Journal of Forest Research, 36, 3063 – 3074.

Mench J. A. (2008). Farm animal welfare in the U.S.A.: Farming practices, research, education, regulation, and assurance programs. App. Anim. Behav. Sc. 2008, 113:298-312.

Pouta E., Heikkila J., Forsman-Hugg S., Jsoniemi M.; Makela J. (2010). Consumer choice of broiler meat, the effect of country of origin and production method. Food quality and preference 21 pp. 539-546.

Salamon, P., (2008). The Agmemod Tool, Version 4, Stylised Model Equations, Braunschweig, 2008

Schmid O., Kilchsperger R. (2009). Technical report on grouping method for animal welfare standards and initiatives, Deliverable 1.1 of Econwelfare Project, January 2010

Schmid O., Kilchsperger R. (2010). Overview of animal welfare standards and initiatives in selected EU and third countries, Deliverable 1.2 of Econwelfare Project, April 2010

Tawse J. (2010). Consumer attitude towards farm animals and their welfare: a pig production case study. Bioscience Horizons Vol. 3 nr. 2.

Toma L., Hattam c., Weldegebriel H., Stott A., (2008). Economic and environmental Implications of animal welfare: a critical review of the literature. Land Economy Working Paper Series, 2008, Nb 30.

Tsakiridu E., Tsakiridu H., Mattas K., Arvaniti E. (2010). Effects of animal welfare standards on consumers' food choices. Food Economics – Acta Agr. Scand. C, 2010, 7:234-244.

Tweeten L. (2009). The economics of animal welfare regulations proposed for Ohio. Released electronically on June 18, 2009 by The Ohio State University.

Van den Bossche, P., Schrijver, N. and Faber, G. (2007). Unilateral Measures addressing Non-Trade Concerns. A study on WTO Consistency, Relevance of other International Agreements, Economic Effectiveness and Impact on Developing Countries of Measures concerning Non-Product-Related Processes and Production Methods. The Hague: the Ministry of Foreign Affairs of The Netherlands

Webster A.J.F. (2001). Farm animal welfare: the five freedoms and the free market. 2001.The Vet. J. 161:229-237.