AgBioForum, 9(1): 51-58. ©2006 AgBioForum.

# Swedish Consumer Preferences for Animal Welfare and Biotech: A Choice Experiment

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This paper compares consumer preferences for immunocastration versus surgical castration and no castration using willingness-to-pay estimates from a choice experiment. Results suggest that consumers place a higher value on pork from immunocastrated pigs than pork from surgically castrated pigs. In contrast, consumers reveal negative valuations of pork from intact boars as compared to pork from surgical castrates. We also show how a binary heteroskedastic logit model can be used to accommodate a larger variance for later choice sets within a choice experiment.

***Key words***: animal welfare, boar taint, choice experiment, consumer, hormone, immunocastration, surgical castration.

## Introduction

Means-end chain theory (e.g., Gutman, 1982) and the theory of planned behavior (e.g., Ajzen, 1991) suggest that an implicative relation between product attributes and physiological or psychological consequences and between these consequences and values governs consumer behavior. A product is regarded as a bundle of attributes; people select products that involve desired consequences while trading off with any undesirable consequences.

Product differentiation strategies are increasingly used in food marketing to attract the interest of consumers for various product characteristics. Product differentiation is achieved through distinct product attributes and is often communicated through product labels or other marketing activities. Long-run competitiveness of food products requires that consumers attribute a value to the product. The attributed value may originate from a plethora of product attributes and/or from conditions in the production process. These attributes and conditions, however, may differ with respect to consumer desirability.

This study investigates the consumer tradeoff for pork meat between consequences related to product attributes characterized by various levels of animal welfare, taste quality, and use of biotechnology in production of pork. Evaluated by personal values, these tradeoffs will reflect which consequences consumers try to achieve in a consumption situation. The specific focus in this study is on castration of male pigs.

Castration of male pigs is routinely performed worldwide in order to prevent the occurrence of the objectionable odor or flavor of boar taint in pig carcasses. Boar taint is caused mainly by androstenone, a testicular steroid, and skatole (3-methylindole from tryptophan by swine intestinal bacteria; Zeng et al., 2001). The latter, however, is easily suppressed by dietary means (Claus, Weiler, & Herzog, 1994). Consumer tolerance of tainted meat is low, as it involves an unpleasant experience of cooking and eating. Large importers of pork (e.g., Japan and Singapore) do not import meat from entire male pigs. There are currently no practical and valid techniques to detect boar taint on the slaughter line (Federation of Veterinarians of Europe [FVE], 2001). Early slaughter to prevent male pigs from reaching sexual maturity is uneconomical in most cases.

The most common castration technique is surgical castration, where the testicles are physically removed. Anesthesia is generally not used due to practical problems and high costs. There is substantial evidence that surgical castration is labor cost intensive, painful, and highly aversive to pigs. Consequently, today's surgical castration can be seen as an ethical issue—given that we see animals as sentient beings—and can also give rise to humans concerns about the animals welfare (FVE, 2001).

Immunocastration by active immunization against gonadotropin-releasing hormone (GnRH) using a synthetic peptide vaccine to suppress the production of male hormones has recently been recognized as a potential mean of castration. The interest in immunocastration is likely due to both a concern for prevention of boar taint and a concern for the welfare of the animals. The vaccine stimulates the male pig's immune system to make antibodies; when these antibodies are attached to the animal's natural GnRH, the hormone cannot initiate reproductive processes. Recent research work shows better growth performance for immunocastrates compared to surgical castrates for Western as well as for Chinese breeds (Zeng et al., 2001, 2002), as immuno-

castration makes it possible to exploit the growth potential of male pigs for most of their productive life. These studies also found that the meat percentage was higher for boars and immunocastrates than for surgical castrates. For immunocastrates, the energy conversion ratio was lower than that of boars but higher than that of surgical castrates (Zeng et al., 2002). Vaccine for immunocastration is currently approved in Australia and pending approval in Taiwan and China. It is not, however, currently approved in the EU or in the United States. Several new vaccines are also under development (e.g., Wang & Walfield, 2005).

The role of public acceptance of immunocastration as an alternative to surgical castration is largely unexplored. Such an acceptance likely involves tradeoffs between animal welfare concerns, food safety risks through use of biotechnology, and food (e.g., taste) quality. Potential food safety risks include possible residues in meat (European Food Safety Authority, 2004). A recent study of the use of biotechnology in food production found consumer preferences for food produced without biotechnology. Use of recombinant growth hormone was found to constitute an undesirable characteristic (Kiesel, Buschena, & Smith, 2005). In light of this, this paper investigates consumers' preferences for immunocastration by comparing willingness-to-pay (WTP) estimates obtained from a choice experiment (CE). The primary finding is that people seems to accept potential food safety risks to alleviate animal welfare problems related to surgical castration. Hence, biotechnology is found to be a "good" rather than a "bad" when consumers choose between product attributes (immunocastration compared to surgical castration) that are equal with respect to taste quality. On the other hand, people prefer pork from surgical castrates over pork from intact boars. This suggests that taste quality dominates animal welfare concerns as product attributes. Our findings are indicative of a Pareto criterion that extends to include the well-being of the animals in production agriculture.

## The Choice Experiment

Market data for sales of pork where male pigs were either not castrated or immunocastrated are not available in Sweden, because there is no market for boars and immunocastration is not yet approved there. Primary data for the evaluation of alternatives for surgical castration were instead collected through a mail survey developed and mailed to consumers in Sweden. The survey contained a CE in which consumers were asked to make choices between pork chops with varying levels of price, type of housing system, castration, tailing, and fixation. The use of a CE in this analysis is motivated as the method allows for a multiattribute valuation and allows estimation of marginal rates of substitution between different attributes and levels of given attributes. CEs have recently been extensively used to assess consumer's choices among food product attributes including food safety (e.g., growth hormones and fed genetic corn in beef) and animal welfare (e.g., Alfnes, 2004; Alfnes & Rickertsen, 2003; Baker & Burnham, 2001; Carlsson, Frykblom, & Lagerkvist, 2005a; Lusk, Roosen, & Fox, 2003). Attributes and levels used in the CE (besides castration) were selected due to policy relevance and results from previous Swedish studies on factors important in consumer valuation of pork meat (Carlsson et al., 2005a; Liljenstolpe, 2003). Table 1 reports attributes and levels in the CE.

## Survey Design

The questionnaire used for the CE was devised together with veterinarians at the Swedish Animal Welfare Agency. The definitive questionnaire was preceded by a pretest using two focus groups (each comprising five individuals). The resulting questionnaire consisted of three parts. The first part included questions about the respondent's and the household's buying habits for pork. The CE constituted the second part. In the introduction to the CE, the purpose of the survey was explained briefly, followed by a "cheap-talk" script suggested by Carlsson, Frykblom, and Lagerkvist (2005b) to reduce the probability of hypothetical bias. Furthermore, an information sheet was included in the questionnaire to describe the process quality variables and provide a short explanation of the choices offered (see Appendix). The third part of the questionnaire contained questions regarding the respondent's socioeconomic and demographic status.

Consumers were asked to make binary choices between various pork chop alternatives. Each alternative was described by four quality attributes and one price variable in a set of six choices. Table 2 provides an example of a choice situation. The choice sets were created using a cyclical design principle (Bunch, Louviere, & Andersson, 1996).[1] One potential criticism of the experiment is a potential lack of realism, in that a food manufacturer or retailer may not label products with, say, "no castration of pigs" or "no fixation." However, even though this might be true, the use of a CE here is motivated, as it closely resembles an actual purchase situation—specifically, the tradeoffs between attributes

**Table 1. Attributes and levels in the choice experiment.**

| Attribute | Levels |
|---|---|
| **1. Type of housing system** | 1.1 Pigs kept indoors in boxes with little straw. |
| | 1.2 Pigs kept indoors in boxes with plenty of straw. |
| | 1.3 Possibilities for pigs to be outdoors. |
| **2. Castration** | 2.1 Surgically castrated pigs (no risk for boar taint; suffering for the piglet). |
| | 2.2 No castration of the pigs (more meaty; lower fat content but risk for boar taint). |
| | 2.3 Immunocastration of pigs (more meaty; less fat content but a low risk for boar taint). |
| **3. Tail docking** | 3.1 The pig has been tail docked. |
| | 3.2 The pig has not been tail docked but tail biting can occur. |
| | 3.3 The pig has not been tail docked. The pig has been raised in a more expensive way to prevent tail biting. |
| **4. Fixation** | 4.1 Keeping sows permanently fixated is allowed. |
| | 4.2 Keeping sows fixated at delivery is allowed. |
| | 4.3 Fixation of sows is banned. |
| **5. Price[a] (SEK/kg)** | 0 (75); +4 (79); +8 (83); +12 (87); +24 (99) |

[a] *At the time the survey was carried out, 1 Swedish Krona (SEK) ≈ $0.13.*

where a product is chosen from several competing options. This mimicking will be an advantage in reducing problems of incentive compatibility. In addition, even if not labelled, any product or process characteristics can still be communicated through means other than a label.

The CE did not include an opt-out alternative. However, each respondent was instructed to answer the CE only if he or she actually consumes the product. Furthermore, for all attributes, the current level was included when designing the choice sets (see Table 1). The comparison between the levels of the attributes in a CE does not require an outside option or an opt-out alternative. This is because we are primarily interested in the comparison between different clearly defined alternatives, such as if the pig has been castrated or not. If we want to compare these it is, from a welfare theory point of view, not necessary to include an opt-out. There could be other arguments for and against including an opt-out alternative. For example, an opt-out alternative could make the choice situation more realistic in providing a no-purchase option, but some respondents could also use it as a simple choice heuristic.

**Table 2. Example of choice set.**

| Attributes | Pork chop 1 | Pork chop 2 |
|---|---|---|
| **Type of housing system** | Indoors, little straw | Indoors, plenty of straw |
| **Castration** | Immunocastrated pigs | Pigs surgically castrated |
| **Tail docking** | No tail docking; tail biting prevented | The pig is tail docked |
| **Fixation** | Permanently fixated | Allowed at delivery and around the time of covering |
| **Price surcharge (SEK/kg)** | + 8 SEK | + 12 SEK |
| **Total cost** | 83 SEK | 87 SEK |
| **Your choice** | | |

As with other valuation methods, there are several potential disadvantages associated with CEs; see for example Lusk and Hudson (2004) for a comparison of valuation methods. The hypothetical nature of the experiments may induce respondents to exaggerate their stated WTP; see for example Carlsson and Martinsson (2001) and Lusk and Schroeder (2004). In order to reduce the potential problem of hypothetical bias, we therefore included the above-mentioned cheap-talk script in the survey.

1. *A cyclical design is a straightforward extension of the orthogonal approach. Strictly dominant choice sets were deleted from the possible set of choices. Moreover, we wanted to avoid too-dominant choice sets. This was done by calculating so-called code sums for each option (Wiley, 1978). In order to calculate the code sum, we arranged the levels of the attributes from worst to best, the lowest attribute level being assigned the value 0; the next, 1; the next, 2; and so on. Thus, for a three-level attribute, the highest value is 2. The code sum is the sum of all these values for each option. By comparing the code sums, one can get a simple indication of which alternatives are particularly dominant. This is obviously a crude approach, and in order for it to work reasonably well, the utility difference between two levels should not differ too greatly across attributes. In our case, we deleted all design alternatives with a code sum difference exceeding 4; there were altogether 64 such alternatives.*

## Model

The households' choices can be described using a random utility model framework. We assume a linear random utility function; in particular, utility is a linear function of money. This means that we assume that the utility of a particular alternative *I* can be described as

$$U_i = v_i + \varepsilon_i = \beta a_i - \gamma c_i + \varepsilon_{ij}, \quad (1)$$

where $a_i$ is a vector of the attributes in alternative *I*, $\beta$ is the corresponding parameter, $c_i$ is the cost associated with alternative *I*, $\gamma$ is the marginal utility of money, and $\varepsilon_i$ is an error term. If the error terms are extreme value distributed, then the probability that a particular alternative is chosen can be formulated as the standard logit probability. Thus, the probability that alternative A is chosen when there is a choice between A and B can be expressed as

$$P[\mathrm{A}] = 1 / (1 + \exp[-\beta(a_\mathrm{A} - a_\mathrm{B}) + \gamma(c_\mathrm{A} - c_\mathrm{B})]). \quad (2)$$

In the literature there is an increasing concern about the role of the scale parameter in discrete choice models and also increasing empirical evidence of the importance of modeling the scale parameter in an appropriate way. In particular, attributes may have effects both on the behavior in terms of affecting the level of the utility but also in terms of affecting the variance of the utility. In order to assess the potential effect on the level of utility (e.g., for a welfare analysis), it is important to make sure that one is not capturing effects on the variance instead; see for example Louviere, Hensher, and Swait (2000), Swait and Adamowicz (2001), and Islam and Louviere (2004). We therefore use a binary heteroskedastic logit model, where the error term has a logistic distribution with mean zero and variance $\exp(\delta z_i)^2$, where $z_i$ is vector of choice set specific characteristics and $\delta$ is the corresponding parameter vector. The question remains what to include in the variance function. One obvious candidate is of course the attribute levels. However, note that the variance function is exponential, and because the discrete choice model depends on difference in attribute levels, it is not advisable to directly include the attribute levels directly in the variance function.[2] Therefore, we include two other characteristics in the variance function. The first one is the value of the difference in cost; the second is a dummy variable for the second half of the total number of choice sets.

Because the utility function is linear in money, the marginal willingness to pay for an attribute is the ratio between the parameter of the attribute and the cost parameter, such that

$$MWTP = \beta / \gamma. \quad (3)$$

In order to allow for heterogeneity in preferences regarding the attribute levels, we will interact the attribute levels with a set of socioeconomic characteristics.

## Results

In the autumn of 2005, 700 surveys were mailed to a random sample of Swedish citizens and legal aliens, drawn from the Swedish census registry, between 20 and 75 years of age. Two reminders were sent out within a three-week period to those who had not replied. Altogether 347 (49.6 %) individuals returned the questionnaire, of whom 285 were available for analysis because of nonresponse to various questions. Although not all of these respondents answered all six choice sets, we still chose to include them in the analysis. Table 3 presents demographic and socioeconomic statistics of the sample.

The primary results of this paper are reported in Tables 4 and 5. Table 4 reports the estimated model. All attribute coefficients are found significant. As expected, the cost coefficient is negative, suggesting that a price increase would reduce the probability that respondents choose the improved attributes in question. The coefficient of the variance function of the absolute cost difference is negative but insignificant. The positive sign of the coefficient of the second half of the experiment implies that the variance is higher for the second half of the experiment. A plausible explanation of this is that respondent gets fatigued and loses interest by the end of the experiment. It is therefore important to control for this effect, because it otherwise could affect the reliability of estimated marginal WTPs.

A number of socioeconomic characteristics were interacted with the various attributes. The socioeconomic variables were income, age, educational level, shopping experience, own consumption frequency (of

2. *For example, we would believe that the effect on the variance is the same for a choice set where the cost of alternative A is 200 Swedish Krona (SEK) and the cost of B is 250 SEK as it is for a choice set where the cost for A is 250 SEK and the cost for B is 200 SEK. However, because only the difference in attribute levels matters, the exponential variance function will not treat them as the same unless we use the absolute difference between them.*

**Table 3. Descriptive statistics of respondents.**

| Variable | Definition | Mean | *SD* |
|---|---|---|---|
| **Experience** | 1 = responsible for most food purchases; 0 = otherwise | 0.45 | 0.50 |
| **Sex** | 1 = female; 0 = male | 0.5467 | 0.498 |
| **Age** | Age (years) | 48.04 | 15.06 |
| **Members** | No. of persons in household | 2.54 | 1.25 |
| **Children** | No. of dependants < 20 years | 0.77 | 1.32 |
| **Highest standard of education** | 1 = University or college; 0 = other | 0.37 | 0.48 |
| | 1 = High school; 0 = other | 0.42 | 0.49 |
| **Income** | Household income net of taxes (SEK) per month | 24,454 | 10,381 |

*Note. According to Statistics Sweden on December 31, 2003, there were 50.24% men and 49.76% women in the population of people between 20 and 75 years old, and with this part of the population the mean age was 45.8 years (standard deviation 15.08). The official statistics (available only for December 31, 2001) report an average of 2.69 individuals per household (standard deviation 1.34). Official statistics report that 27.7% has university or college education, and 48.6% to have no more than high school. The average disposable income (net of taxes and social transfers) for all households in Sweden in 2004 was 17,742 SEK/month, while the average disposable income for cohabitants with one child amounted to 30,525 SEK/month.*

**Table 4. Estimated binary heteroskedastic logit model.**

| Attribute | Level[a] | Coefficient | *P*-value |
|---|---|---|---|
| **Type of housing system (base= indoors, little straw)** | Indoors, plenty of straw | 0.555 | 0.0001 |
| | Outdoors | 0.821 | 0.0000 |
| | Indoors, plenty of straw * female | 0.472 | 0.0102 |
| | Outdoors * female | 0.553 | 0.0027 |
| | Indoors, plenty of straw * experience | -0.373 | 0.0289 |
| | Outdoors * experience | -0.496 | 0.0055 |
| **Castration (base = surgical castration)** | No castration | -0.297 | 0.0008 |
| | Immunocastration | 0.295 | 0.0020 |
| **Tailing docking (base = tail docked)** | No tail docking, tail-biting can occur | -0.200 | 0.0514 |
| | No tail docking, tail-biting prevented | 0.148 | 0.0833 |
| **Fixation (base = permanent)** | At delivery | 0.754 | 0.0000 |
| | Banned | 0.711 | 0.0000 |
| | At delivery * female | 0.292 | 0.0641 |
| | Banned * female | 0.572 | 0.0033 |
| **Cost** | | -0.019 | 0.0000 |
| **Variance function** | | | |
| **Abs (difference in cost)** | | -0.020 | 0.1380 |
| **Second half of the experiment** | | 0.571 | 0.0002 |
| **Log likelihood** | 983 | | |
| **Restricted log likelihood** | 1138 | | |
| **No. of observations** | 1642 | | |

[a] *Female and experience (do the shopping by themselves) represent socioeconomic interaction variables.*

pork), household consumption frequency (of pork), farming background, household size by number of family members, and number of dependants under the age of 20 years. Due to space limitations, the final model includes only those socioeconomic interaction variables that had a significant effect at the 10% level. The only characteristics that had a significant effect, for type of husbandry and fixation, were female and experienced consumers (those who are mainly responsible for food purchase in the household). Females were on average found to derive lower levels of utility than men for use of more straw in an indoor housing system, for allowing pigs to be outdoors, and for forms of fixation more animal-friendly than permanent fixation. Interestingly,

**Table 5. Mean marginal WTP, Swedish Krona (SEK) per kg.**

| Attribute | Level | Mean marginal WTP (SE) |
|---|---|---|
| **Type of housing system (base= indoors, little straw)** | Indoors, plenty of straw | 34.4 (8.4) |
| | Outdoors | 47.9 (9.6) |
| **Castration (base = surgical castration)** | No castration | -15.9 (5.34) |
| | Immunocastration | 15.7 (5.3) |
| **Tail docking (base = tail docked)** | No tail docking; tail biting can occur | -10.6 (5.9) |
| | No tail docking; tail biting prevented | 7.9 (4.4) |
| **Fixation (base = permanent)** | At delivery | 48.6 (10.8) |
| | Banned | 54.3 (10.8) |

*Note. the base price was set at 75 SEK/kg. Standard errors are shown in parentheses.*

respondents classified as experienced were found to derive negative utilities from indoor housing systems with plenty of straw as well as for outdoor production systems. The disparity in utility levels between experienced and inexperienced respondents is substantial for these attribute levels.

Table 5 reports estimates and standard errors for the mean marginal WTP for the various attribute levels, standard errors are calculated using the Delta method (Greene, 2000). Mean marginal WTP is estimated according to Equation 3. Note that these are WTP measures compared to the base case for each attribute. The hypotheses $H_0$: $WTP^{surgical\ castration} = WTP^{immunocastration}$ and $H_0$: $WTP^{surgical\ castration} = WTP^{no\ castration}$ can be rejected at any conventional level. The hypotheses were tested using two-sided tests, because both positive and negative price premiums are possible a priori. Hence, a significant positive WTP for immunocastration and a significant negative WTP for no castration was found. This implies that consumers associate a positive utility from consumption of immunocastrated pork compared to pork originating from surgical castrates and negative utility from pork originating from intact boars compared to pork from surgical castrates. The negative WTP for the no-castration alternative is similar to the results presented by Liljenstolpe (2003). The latter study included castration with anesthesia and no castration together with six other attributes in a CE directed to Swedish consumers, in which pork fillets of various characteristics were evaluated. Using a mixed logit estimation, Liljenstolpe reported a price discount of 13.8% for no castration and a price premium of 39% for castration with anesthesia.

The estimates in Table 5 are also instructive for comparing the ranking of attributes and levels. Consumers associated higher WTP for fixation of sows and type of housing system for fattening pigs than for castration. Interestingly, when comparing mean WTP for ban on fixation with fixation at delivery, the hypothesis that they are equal cannot be rejected at any conventional levels. However, there is a significant difference between the WTP for outdoor production and indoor production with plenty of straw.

Tail docking of fattening pigs was regarded as the least important attribute among those included in the study. Note that the results related to the various levels of the tail-docking alternative are similar to the results for the castration attribute. In relation to the base case (where tail docking is performed), respondents associated a negative WTP for the alternative with no tail docking but where tail biting can occur. This implies that tail biting, which induces pain, suffering, and possible infections to animals, is viewed as a more important animal welfare problem than tail docking. This is a reasonable result, as tail biting is an indicator of a poor environment or other types of stress. We interpret this result as indicating that consumers prefer pork from pigs that have been tail docked if there are chances that tail biting can occur. Consistently, a positive WTP is found for the alternative with no tail docking but where tail biting is prevented.

## Conclusions

Europeans are in general more reluctant to the combination of biotechnology and food. It is debatable whether this is due to recent food scares (such as bovine spongiform encephalopathy), successful campaigns by environmental lobbyists, or the central role of food and cooking in European culture. Swedes have been shown to be relatively more averse towards genetically modified organisms (for example) than many other Europeans (Hoban, 1997).

Using a choice experiment, we estimated the WTP for several process attributes for pork meat. Included attributes related to potential animal welfare enhancing measures in pork production. Our results confirm the results from studies of Carlsson et al. (2005a) and Liljenstolpe (2003) in finding that consumers placed high values in allowing fattening pigs to be outdoors. In addition, consumers strongly opposed fixation of sows. Based on our results, however, we cannot say that a ban of fixation would reduce negative external effects from pork production.

Our results also indicate that consumers associate a benefit from the consumption of pork from immunocastrated pigs compared with pork from surgically castrated pigs. In contrast, consumers reveal negative valuations of pork from intact boars. These findings imply that animal welfare concerns are more emphasized than biotechnology aversion or food safety risk when consumers compare immunocastration and surgical castration. With a low risk for boar taint, these alternatives are identical with respect to taste quality. In addition, consumers place higher values on pork from surgically castrated pigs than on pork from intact boars. Hence, food quality concerns apparently dominate animal welfare concerns in avoiding boar taint. Taken together, our findings suggest that immunocastration of male pigs represents a Pareto-efficient improvement in pork production. Consumers will be able to maintain taste quality while improving the well-being of pigs and avoiding the problems related to surgical castration. The use of biotechnology in this setting, therefore, is regarded as a desired production attribute.

If consumers in other countries share the same type of values, there are important policy implications to be drawn from this study. Under current legislation in many countries surgical castration has been accepted, lacking reasonable alternatives, as many markets for pork do not accept boar meat, even though surgical castration impedes the well-being of animals. Immunocastration provides several potential public as well as agribusiness advantages over surgical castration, including animal welfare improvements, potential cost savings in procedures, and gains from higher growth rates for pigs. Our findings suggest that immunocastration is a socially viable alternative. Therefore, the abolition of surgical castration of pigs should be supported.

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## Appendix: Information Sheet—Pork Meat

To facilitate your choices, this sheet provides short presentations of product attributes of pork.

### *1. Type of Housing System*

Fattening pigs that have the opportunity to be outdoors or are kept outdoors usually have a larger chance of satisfying their natural behavior compared to pigs kept indoors. This is especially the case for pigs in indoor production systems that allow for only a minimum level of straw. Outdoor production as well as handling of straw is related to greater costs for the producer.

Possible alternatives are:

- pigs kept indoors in boxes with little straw;
- pigs kept indoors in boxes with plenty of straw; or
- possibilities for pigs to be outdoors.

### *2. Castration*

Pork from uncastrated male pigs can have a strong boar taint, which will appear as an odor mainly during heating. Different people have different sensibilities towards boar taint.

In Sweden, almost all male pigs are castrated in order to avoid boar taint. Castration is done without anesthesia during the first week; the piglet suffers from castration. In several countries, research is going on to develop alternatives to surgical castration. One method that is used in Australia (for example) is that pigs are vaccinated against an endogenous substance that affects hormone development. This is called *immunocastration*. The sexual development of the pigs will thus be delayed and boar taint can be avoided. Uncastrated pigs grow faster and develop more muscles and lower fat content in the meat.

Possible alternatives are:

- surgical castration of pigs (no risk of boar taint, suffering for the piglet);
- no castration of pigs (meatier, lower fat content, risk of boar taint); or
- immunocastration of pigs (meatier, lower fat content, low risk of boar taint).

### *3. Tail Docking*

Fattening pigs can develop a type of behavioral disorder called *tail biting*, in which the pigs bite on and finally bite off each other's tails. Tail biting can be caused by a poor environment, inferior fodder, or other types of stress. It causes pain, suffering, and infections. Tail biting is prevented in other countries by docking the piglets' tails. Tail docking is currently banned in Sweden.

Possible alternatives are:

- the pig has been tail docked;
- the pig has not been tail docked and tail biting can occur; or
- the pig has not been tail docked but has been raised in a more expensive way to prevent tail biting.

### *4. Fixation*

During delivery there is a risk that the sow may by mistake lie down on her piglets, causing their deaths. This is especially a problem if the barn is noisy and the sow has difficulty hearing her piglets. This problem is prevented in many countries by keeping the sow *fixated*, which prevents her from turning around. Sows are usually fixated during their entire life. Fixation causes suffering, because sows have a strong natural behavior to move around and to settle before delivery. In Sweden, sows are allowed to be fixated during one week around the time of delivery and also around the time of covering.

Possible alternatives are:

- sows are permanently fixated;
- sows are allowed to be fixated at delivery and around the time of covering; or
- fixation of sows is banned.