Zeitschrift: Yearbook of socioeconomics in agriculture : Agrarwirtschaft und Agrarsoziologie = économie et sociologie rurales

Herausgeber: Schweizerische Gesellschaft für Agrarwirtschaft und Agrarsoziologie

Band: - (2009)

Artikel: Apples compared to apples : attitudes towards cisgenic and transgenic breeds

Autor: Haller, Therese

DOI: https://doi.org/10.5169/seals-966645

Apples compared to Apples: Attitudes towards cisgenic and transgenic breeds

Therese Haller, ETH Zurich, Institute for Environmental Decisions IED, Group AFEE, Zürich

Genetically modified (gm) crops are disliked by a majority of the population in most European countries. Until now, it has not been known whether the same lack of acceptance that is known to apply to *transgenic* crops will apply to *cisgenic* crops - plant breeds produced using gene technology, but containing no DNA foreign to their species. To study a potential difference in acceptance, we conducted a survey using the actual case of fire blight - a disease affecting several species of fruit trees - as a context for our questions. Five different phytosanitary measures against fire blight were proposed to the respondents, including cisgenic and transgenic apple breeds and treatment with the antibiotic streptomycin. The respondents (n=665), a random sample from the Swiss population, were asked about their attitudes, the effectiveness they expected of each of the measures, and their willingness to consume the produced apples. Only about 40 % of the respondents distinguished between cisgenic and transgenic apples when rating them. This group tended to favor the cisgenic apple breeds not only to the transgenic ones but also to the option of antibiotic treatments. Structural equation models were used to test the dependence of the attitude towards the phytosanitary measure on the other two factors. This analysis revealed analogies between the (dis-)acceptance of gm breeds and antibiotic treatments: in both cases, the expected effectiveness of the measures had little or no impact on the subject's overall judgment.

JEL Classification: D12, D84, Q18, Z13

Therese Haller: Apples compared to Apples: Attitudes towards cisgenic and transgenic breeds: Yearbook of Socioeconomics in Agriculture 2009, 3-34

1. Introduction

In Switzerland, a major part of the population objects to genetic engineering applications in the field of agriculture. In November 2005, Swiss voters approved a five-year moratorium on genetically modified (gm) crops and livestock (BUNDESRAT 2006). Several studies (e.g. SIEGRIST 2000, BONFADELLI et al. 2007) showed a clear distinction in perceptions and attitudes between red (medical) and green (agricultural) applications of the technology. Whereas in the case of red applications the expected benefits outweigh the potential risks, "*green biotechnology is still regarded as risky and without practical benefits and, morally, it is against the natural order of things*" (BONFADELLI et al. 2007, p.118).

This finding is not a Swiss particularity, but rather seems to be true for most of Europe. Especially in the neighboring German-speaking countries, consumers perceive gm-food as one of the major potential risks in nutrition. In a Eurobarometer study on risk perception (EFSA and DG-SANCO 2006), 24 % of the Austrian and 19 % of the German respondents spontaneously thought of gm-food when asked about possible problems or risks associated with food.

It has been argued that the lack of acceptance of the green applications of genetic engineering hinges on a perceived absence of benefits (Gaskell et al. 2006, p. 18). In fact, medical problems are more likely than agricultural challenges, such as plant diseases, to touch the lives of most citizens in European countries. Therefore it seems natural that it is easier to perceive potential benefits in red applications than in green ones. However, there exist successful green applications, for example, insect-resistant gm crops. Genes from Bacillus thuringiensis (Bt) for a toxin against specific insect species were introduced in tobacco (Vaeck et al. 1987), and other crops, such as cotton and maize, allowing considerable reductions in insecticide use (Brookes and Barfoot 2005 p.193). Also, a chemically synthesized Bt-like sequence (crylAc) was introduced to apple breeds which showed the desired resistance against the codling moth (Cydia pomonella) (IBANEZ and DANDEKAR 2007, p. 264). Furthermore, successful attempts to increase resistance against apple scab (Venturia inaequalis - a fungus) and fire blight have been reported (GESSLER and PATOCCHI 2007). Although some of this research is promising, up to now, none of the transgenic apple cultivars has been brought to commercial use. IBANEZ and DANDEKAR (2007, p. 250) state

that the negative perception of gm plants by the public has slowed the development of transgenic plants, and that necessary yield and quality trials have not yet been conducted. The development of cisgenic apple breeds is under progress, being enabled by recent technological advances (e.g. the "clean vector technology", KRENS et al. 2004).

As public acceptance is a crucial point for the commercial success of gm apples, some researchers hope for more favorable perceptions regarding cisgenic crops. It has been argued (see JOCHEMSEN 2008) that genetic modifications are less problematic from an ethical point of view when the gene sequences used are taken from the species that is to be modified (cisgenesis). As a consequence, compared to transgenic crops, cisgenic crops could also be more acceptable for consumers and producers (GESSLER and PATOCCHI 2007, p. 128).

The aim of our study is to examine the attitudes towards cisgenic and transgenic crops, to compare them to each other and to the attitudes towards their alternatives. To provide a concrete frame, we examine these issues in the context of apples and the challenge of fire blight.

1.1 Background on fire blight disease

With its major break-out in 2007, fire blight is a topic that is likely to have been noticed by the population. Swiss media extensively reported about this plant disease. Fire blight infects apple trees or other Maloideae and is caused by the bacterium *Erwinia amylovora*. One strategy of combat is the application of the antibiotic streptomycin during the blossom period. This option is regarded controversially; in Switzerland, its application was not permitted until 2008, when it was allowed under strong restrictions (e.g. only farm-specific permits). One alternative to streptomycin is a yeast preparation, which is also approved for organic farming. Its application has shown quite satisfactory results, although it is less effective than the antibiotic. Another strategy is to breed more resistant apple varieties. But due to the long generation interval of 3-5 years, this is a difficult and time-consuming task (KOLLER et al. 1995, p. 20). Fire blight resistance is one main target for genetic engineering in apples (see GESSLER and PATOCCHI 2007, p.122-124).

2. Methodology

A. Research Design

While using basically the same group of technologies, cisgenesis and transgenesis lead to products that are clearly distinct with regard to their DNA. However, this does not mean that the population perceives them as anything distinct. Distinction is a matter of categorization; creating categories is a cognitive act of grouping distinguishable objects or events in order to treat and label them equivalently (see MERVIS and ROSCH 1981). This also applies to the evaluations of these objects.

One form of evaluation is the attitude which, as a scientific concept, can be defined as *"a psychological tendency that is expressed by evaluating a particular entity with some degree of favor or disfavor"* (EAGLY and CHAIKEN 1993, p. 1). As such, attitudes are conceived as latent constructs that influence the person's beliefs, affective reactions and behaviors. Therefore, cognitive, affective and behavioral observation data can be used as indicators (see HIMMELFARB 1993). In questionnaires - including the one used in our study - self report measures such as rating scales are often used to assess attitudes. While the theoretical concept assumes an attitude to be a stable cognitive construct, concrete evaluations are always susceptible to the context (KROSNICK et al. 2005, p. 27f). Therefore, it is important to define the frame in which the evaluations are performed.

In our study, the frame is given by a problem: fire blight threatening apple production. Thereby, the gm apples are represented as two among other phytosanitary measures. Two of the measures included in the study are effective in the short term, and three are effective only in the long term:

Measure 1: Antibiotic treatment

Measure 2: Yeast preparation treatment

Measure 3: Traditional breeding

Measure 4: Genetic engineering, apple genes only

Measure 5: Genetic engineering, genes from other species

Measures 1 to 3 are compatible with Swiss law. For measures 4 (cisgenic) and 5 (transgenic), research is allowed but the cultivation of such trees is banned because of the abovementioned moratorium.

In order to compare the perceptions of the different measures, three criteria were chosen to elicit ratings:

- the attitude as an over-all opinion on the measure
- the measure's expected effectiveness
- the willingness to buy and consume apples produced in such a way

Our analysis focuses on comparing the ratings for various measures; the absolute meaning of the evaluations is of limited validity in other contexts. Just as stated and revealed preference are divergent in many situations, there is evidence that consumers' stated purchase intentions can both over- and understate actual purchase rates (see MORWITZ 1997). KASSARDJIAN et al. (2005) report that in experimental auctions, a majority of the New Zealander participants showed a positive willingness to buy gm apples, although before the experiment, only about a quarter of them supported the presence of gm food in supermarkets.

In our study, measure comparison is performed on two levels. First the measures are compared with regard to single-criterion ratings (e.g. their distributions). Then measures are compared regarding the relationships between the criteria. On both levels, it is useful to divide the sample by gender, as there is evidence that women are more concerned about technological and environmental risks than men are (see SIEGRIST 2003, p. 47).

In the first level of analysis, traditional breeding is used as a point of reference. In the questionnaire, the term "traditional" was used to denote a default strategy to address agricultural problems.

Some comparisons are of special interest and engender the following research questions:

R1. *Is there a difference between evaluations of antibiotic treatment as compared to cis- or transgenic apple breeds?* Given the strong objection to gm plants, this comparison can be expected to reveal a preference for antibiotic treatment.

R2. *Does it make a difference whether a genetically modified apple contains apple genes only as opposed to genes from other species?* We test the hypothesis of equivalent ratings.

R3. *Which proportion of the respondents distinguishes between cisgenic and transgenic apples?* Based on the concept of categorization, a failure to make such a differentiation can be interpreted as perceiving only one category of gm apples, which encompasses cisgenic as well as transgenic apples. Consequently, distinguishing can be interpreted as perceiving two different categories of gm apples or as one category including more and less representative examples.

On the second level, the relationships between the criteria are estimated separately for each measure, using path models and mixed structural equation models with one latent variable (see KLINE 2005 for the technique). The attitude towards a measure against fire blight is assumed to depend on the willingness to consume the apples produced in that way and the expected effectiveness of the measure to combat fire blight. This causal structure is based on the hypothesis that an overall judgment is dependent on judgments regarding more specific criteria. However, the causalities of the relations could be reversed in two cases. First, people who experience difficulty in making a judgment about the effectiveness of a phytosanitary measure might use their general attitude towards the measure as a cue (see KAHNEMAN 2003, p. 707). Second, some respondents might refuse to consume apples as an act of protest against a specific measure. These cases of response behavior must be expected, especially if a measure is controversial, as is the cultivation of gm apple trees. However, the general attitude towards the cultivation of gm plants, which was included in the model as a further step of analysis (figure 1), can be expected to take the place of a causal factor for protesting non-consumers of gm apples.

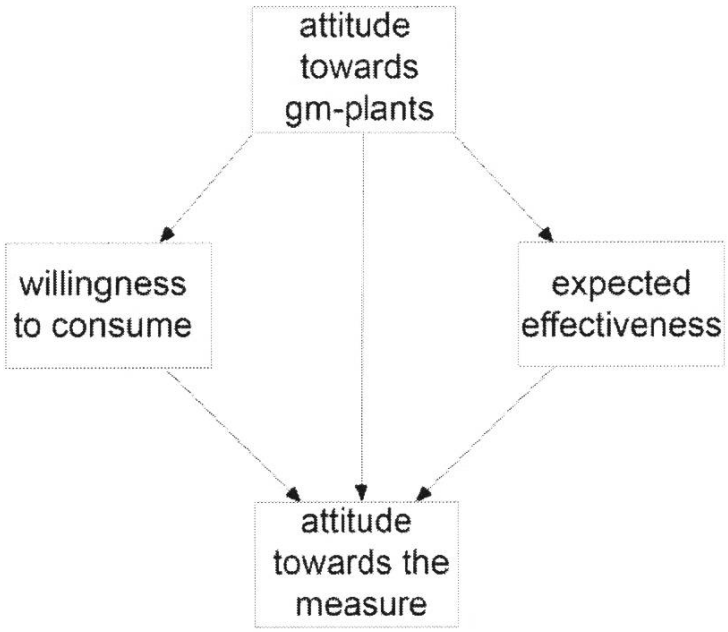


Fig. 1: Factors influencing the attitude towards the measures against fire blight.

It must be clear that other important factors might influence the subject's attitude towards phytosanitary measures. As far as gm products are concerned, SIEGRIST (2008) mentions perceived benefit, perceived risks and perceived naturalness, as well as trust, to be important factors for the acceptance of such technologies. The expected effectiveness in this study reflects perceived benefit, whereas the willingness to consume can be supposed to be influenced by the perceived risks and naturalness. The simplified model in this study was chosen in order not to overwhelm the evaluation process, as five measures had to be compared by the respondents.

Consequently, the last research question concerns these relationships:

R4. *Are there specific patterns in the relationships among the criteria rated for the different phytosanitary measures?* The measure-specific ratings regarding effectiveness and willingness to consume can be expected to show significant effects in all models; the general attitude towards the cultivation of gm plants can be expected to be significant in the models for gm measures only.

B. Questionnaire

The data for this study were collected with a questionnaire sent by mail to a sample of the population. The general subject of the survey was the population's perception of agriculture and their expectations towards it.

Only one section of the questionnaire was dedicated to the topic of the present paper. It included a text page (see appendix 1) where the problem of fire blight and the measures of abatement were briefly described. Thereby, it was assured that everyone had access to the same information. However, we did not determine whether the respondents actually read the texts. The fire blight section started with a question block in which the respondents were asked to rate the importance of combating fire blight and to indicate their perception of the seriousness of this plant disease. These questions served to focus the respondents on the problem to be solved. The ratings reflect whether the respondents took the problem seriously. After this introduction section, respondents had to appraise all five measures, one criterion after the other. Earlier in the same questionnaire, the respondents had been asked about their opinions regarding the cultivation of genetically modified plants in general. To measure the variables concerned by the present study, we used five-point rating scales.

C. Data and representativeness

In mid August 2008, 1500 questionnaires were sent to a random sample of addresses from the phone book for the German-speaking part of Switzerland. The addressees were reminded twice and data collection took place until mid-November. Finally, 665 questionnaires (44 %) were returned. For some parts of the analysis, only the completely answered questionnaires were used (n=537).

In total, 51,7 % of the respondents are women, which corresponds well to their proportion in the adult population. Younger persons (below 40) are underrepresented in our study as compared to the general population. It can be assumed that this is partly caused by an underrepresentation of this generation in the phone book. For fix net phones, registration in the phone book is the default, but for mobile phones book listings are added only upon request. Experts estimate that about 10-15 % of the adult Swiss population is not reachable by the phone book database because they are not registered or because they do not have a tele-

phone in their households (see JANN 2006). This might also have excluded persons with very low income from the sample. Furthermore, as has to be expected when conducting a written survey, less educated people are underrepresented in the sample. In this survey, this is particularly the case for women with no post-obligatory education, who in 2008 represented 16,8 % of the female population aged between 25-64 years (BFS 2009). These women make up only 6 % of the sample. These are the major limitations of the representativeness of this study. As the attitude towards gm plants was not the major topic of the survey, there should not be any bias due to the respondents' interest in the topic.

3. Results

A. Distributions

The answers to the questions introducing the problem of fire blight suggest that the respondents took the topic seriously. On a five-point scale, 61 % of the respondents rated it as very important to combat fire blight, and 48 %, 51 % and 36 % thought the possible consequences (respectively, farmers losing income, danger to meadow trees and fewer apples from Swiss production) were very grave.

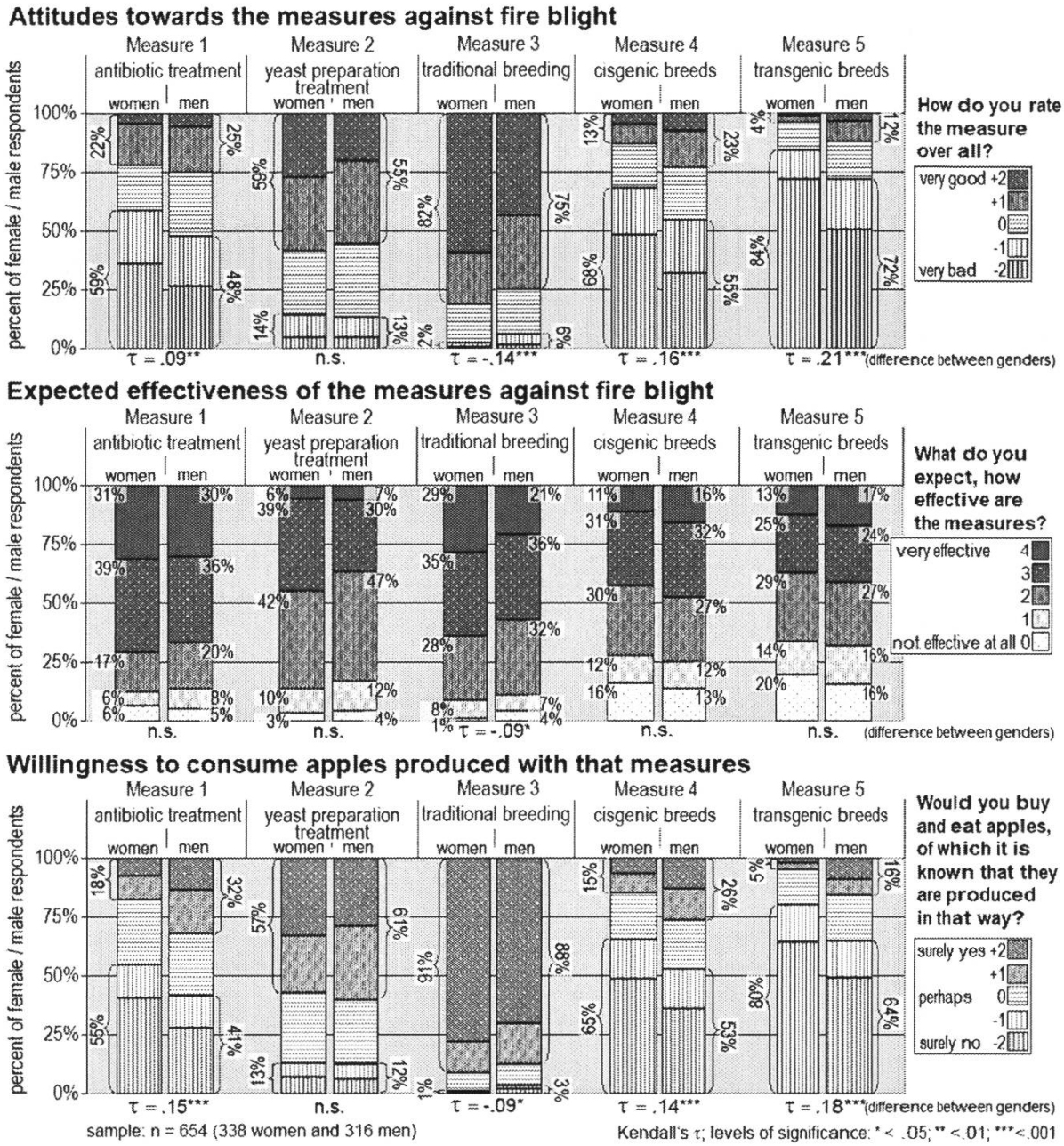


Fig. 2: Ratings of the five measures over three criteria, grouped by gender.

Figure 2 shows the responses regarding the different measures to combat fire blight, grouped by the respondents' gender. Some differences between genders are significant: When judging classical breeding, women state a more positive attitude and a higher willingness to con-

sume, but men state more positive attitudes and higher willingness to consume when judging the measures implying antibiotic treatment or genetic engineering. This is consistent with the findings of other studies (e.g. SIEGRIST 2003). For the expected effectiveness, there is a significant difference only regarding the measure of classical breeding, which was rated slightly higher by women. No gender effect is shown for the yeast preparation measure. One detail to point out is the willingness to consume apples produced with antibiotic treatment: 55 % of the female respondents and 41 % of the male respondents state that they (rather or surely) would not buy and eat such apples. Since the market share of organic apples is not that large, such a difference between intention and purchase behavior can be explained by unawareness of one's own preferences or a lack of knowledge of characteristics of the product (see MORWITZ 1997, p. 58-61): If these respondents were attentive, they all should confine themselves to eating organic apples; the trees the other apples come from might have been treated with antibiotics.

For purposes of interpretation it is useful to compare the ratings for the different measures with the ratings for traditional breeding. Figure 3 shows that antibiotic treatment is the only measure that is expected to be as effective as breeding. This comparison is somewhat doubtful, though, one being a short-term and the other being a long-term measure. The cis- and transgenic measures are expected to be less effective. The willingness to consume and the attitude are closer to traditional breeding for yeast treatment than for the other measures. But even if this measure offers little reason for skepticism, it is judged less positively compared to traditional breeding. Nevertheless, antibiotic treatment and the cis- and transgenic apple breeds meet much less acceptance. As expected, antibiotic treatment is still more acceptable than genetic engineering. The difference is significant for all criteria and for both cis- and transgenic breeds. Thus, considering the sample as a whole, research question R1 can be answered as expected. However, it must be noticed that, with regard to the attitude and the willingness to consume, cisgenic breeds were rated more similarly to antibiotic treatment than to transgenic breeds.

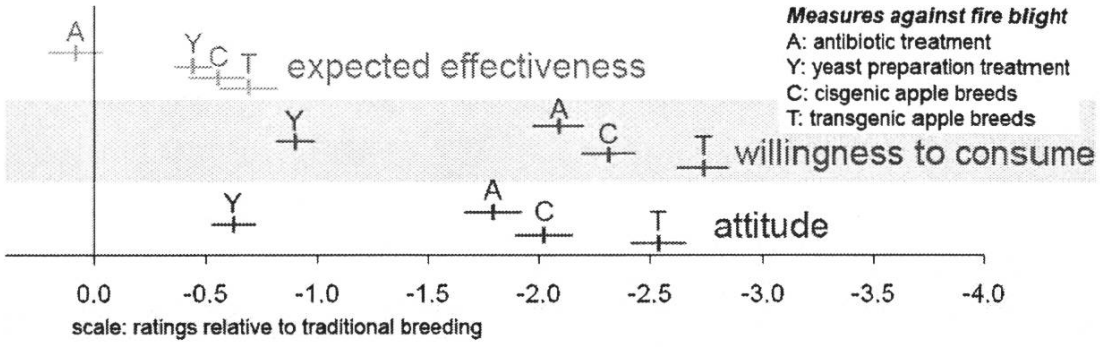


Fig. 3: Ratings of the measures relative to traditional breeding.

Some respondents rated a proposed phytosanitary measure uniformly over all three criteria. The tendency of raters to appraise different criteria "*as if they were functions of a global evaluation or of the salient features*" (COOPER 1981, p. 219) is called the halo effect. In our study, the halo effect seems to increase with skepticism towards the measure: Whereas the proportion of uniform ratings is negligible for traditional breeding and yeast preparation (0,5 and 2,3 % of the respondents), and small (6,4 %) for the antibiotic treatment, this value rises to 14,2 % and 16,3 % for cis- and transgenic breeds. Theoretically, true halo must be distinguished from illusory halo (COOPER 1981, p. 220): While the first reflects a true correlation of judgments over different criteria and therefore represents no problem for measurement, the second consists in answers not reflecting true opinions. The causes of illusory halo can be various, including insufficient motivation or knowledge of the respondent. Especially when a criterion is difficult to judge, respondents may substitute the attribute in question with a heuristic one (KAHNEMAN 2003, p. 707-710). Compared to a statement about one's own willingness to consume specific apples, a statement about the effectiveness of the measure must be expected to be a more difficult task. Therefore the ratings for this criterion are more likely to be biased by a halo effect. Actually, separating the respondents with uniform ratings leads to a distribution of expected effectiveness of transgenic breeds that, visually, is much closer to normality (figure 4). The illusory halo contribution cannot be estimated. The probability for uniform responses over all criteria seems to increase with opposition to the measure. Strong opposition might impede the acceptance of possible advantages of the disliked thing, or it might impede the consideration of a criterion's content.

Therefore, the halo effect in this case can be interpreted as an extreme form of a negative bias caused by strong opposition. A better education might help to mitigate this bias: Only 9% of the persons with higher education, but 27% of the respondents without post-obligatory education have answers characterized by the halo effect for the transgenic measure.

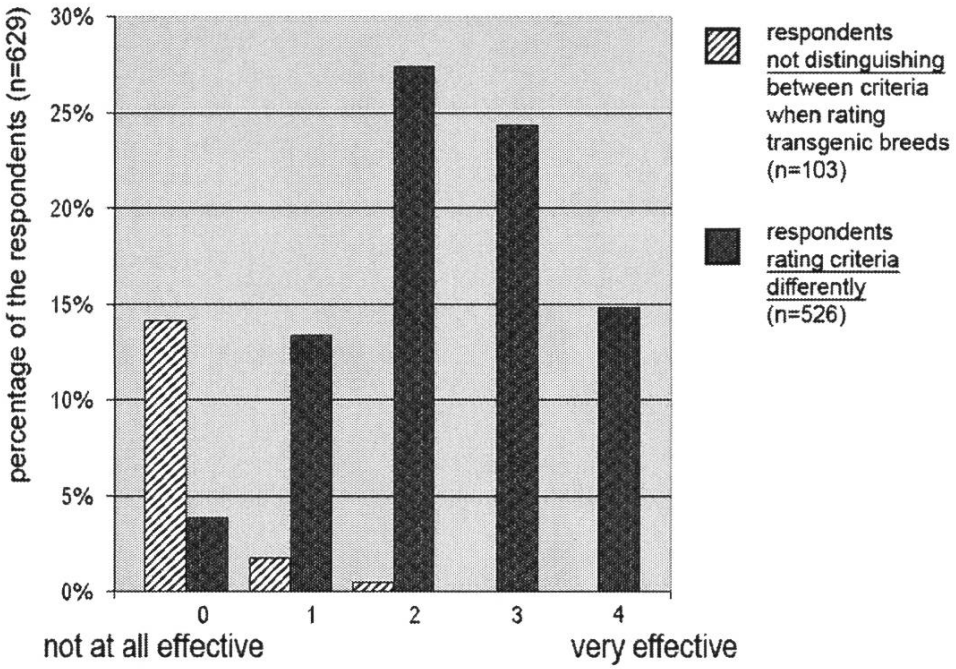


Fig. 4: Expected effectiveness of transgenic breeds against fire blight.

The proportions of respondents who expect traditional breeding to be more effective, compared to cis- or transgenic breeds, are 43 % and 48 %, respectively. About one third of these respondents show a halo effect in their judgments of transgenic breeds. Only 24 % or 23 % of the respondents expect improved effectiveness from cis- or transgenic breeds. Without counting the halo-respondents, this proportion is shifted in favor of genetic engineering, though without reversing the majorities (34 % or 40 % consider traditional breeding to be more effective; about 28 % each seem to favor cis- and transgenic breeds).

Table 1 displays the ratings for both genetic engineering measures. The hypothesis of equivalent ratings (research question R2) is tested on all

three criteria: the attitude, the willingness to consume and the expected effectiveness. As the differences between the pairs of variables are not normally distributed, a non-parametrical test is conducted as well as a parametrical one.

The hypothesis of equivalent ratings for both measures is rejected for all three criteria, with the cisgenic breed rated more positively. The difference in the ratings is highest for the attitude and smallest for the expected effectiveness.

Tab. 1: Tests for the hypothesis of uniform ratings over cisgenic and transgenic breeds

criterion		**attitude**	**expected effectiveness**	**willingness to consume**
Wilcoxon signed-rank test	Z	-11.840	-5.118	-10.946
	sig.	.000	,.000	.000
	Ties	425=67 %	512=82 %	479=74 %
t-test	t	13.512	4.992	12.155
	sig.	.000	.000	.000
n		636	627	646
direction of difference		cisgenic is rated more positively than transgenic	cisgenic is rated more positively than transgenic	cisgenic is rated more positively than transgenic

It is important to note that the number of ties (same value for both variables) is high, ranging from 67 % (attitude) to 82 % (effectiveness). Among respondents, 60 % do not distinguish between cisgenic and transgenic apples in any of the three criteria. Consequently, the answer to research question R3 is 40 %. There is no significant difference in this proportion between genders and age groups. However, when dividing the sample in non-distinguishing respondents ("cis=trans group") and distinguishing respondents ("cis≠trans group"), there is a significant correlation between group membership and education (Kendall's τ = 0,09, $p<0,05$). At the lowest educational level, 70 % of the respondents do not

distinguish; among respondents with university degrees, this percentage drops to 54 %.

The attitude towards cisgenic breeds is much more positive in the cis≠trans group than in the cis=trans group, but there is no significant difference between the groups regarding the attitude towards transgenic breeds (see figure 5). There are significant correlations of group membership and expected effectiveness or willingness to consume, in either case confirming higher ratings in the "cis≠trans group" for both gm breeds. However, the difference between the groups is much smaller for the transgenic breeds than for the cisgenic breeds, and, in the case of the willingness to consume, the differences mainly concern the distributions between the negative categories. These results suggest that differentiating respondents are not generally more positive about gm apples, but that they do not perceive cisgenic apples as in the same category as transgenic ones.

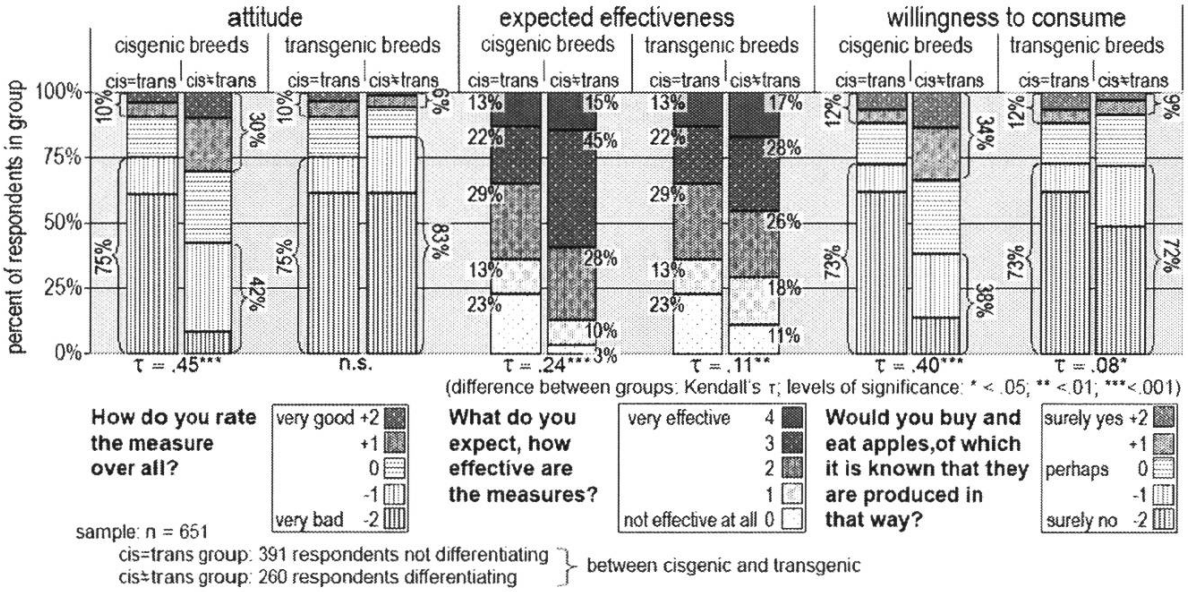


Fig. 5: Comparison of respondent differentiation between cis- and transgenic breeds.

Next, to provide a second answer to research question R1, the ratings by the cis≠trans group regarding cisgenic breeds are compared to the ones regarding antibiotic treatment (table 2). As it turns out, this group

seems to favor cisgenic breeds to antibiotic treatment. This finding regards the attitude and the willingness to consume the apples, whereas the antibiotic treatment is considered to be more effective than cisgenic breeds. One explanation could be that antibiotic treatment is effective in the short term. In fact, ratings for the expected effectiveness from the cis≠trans group show no significant difference between the two long-term measures cisgenic breeds and classical breeding.

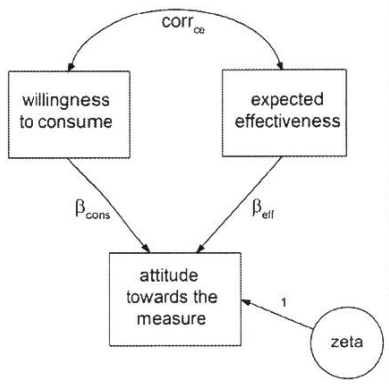
Tab. 2: Tests for uniform ratings regarding cisgenic apples and antibiotic treatment, cis≠trans group only

criterion		attitude	expected effectiveness	willingness to consume
Wilcoxon signed-rank test	Z	-3.454	-4.859	-2.819
	sig.	.001	.000	.005
	Ties	74=29 %	99=39 %	84=33 %
t-test	t	-3.838	4.784	-2.930
	sig.	.000	.000	.004
n		253	251	256
direction of difference		cisgenic is rated more positively than antibiotic	antibiotic is rated more positively than cisgenic	cisgenic is rated more positively than antibiotic

B. Relationships between the variables

At the second level of analysis, we built path models. These models describe the linear dependencies of the attitude towards each measure on the expected effectiveness of that measure and the willingness to consume the apples produced. For this very simple model, the solution calculated by AMOS is equivalent to what would be found estimating a linear regression, despite the use of a different algorithm (fitting the covariance matrix with the maximum likelihood method instead of minimizing the sum of squared residuals over the cases).

Tab. 3: Path model for the attitudes towards the measures against fire blight



measures:	R^2	β_{cons}	β_{eff}	$corr_{ce}$
antibiotic treatment	**0.49**	0.66***	0.10**	0.29***
yeast preparation	**0.36**	0.47***	0.26***	0.31***
traditional breeding	**0.31**	0.27***	0.42***	0.29***
cisgenic breeds	**0.62**	0.73***	0.15***	0.32***
transgenic breeds	**0.59**	0.74***	0.09***	0.25***

n=537
R^2: part of the variance in the attitude explained by the model
levels of significance: ** < .01; *** < .001

The models for each measure were estimated only for the respondents who answered all the questions (n=537). First it must be noted that the explanatory power of the models for classical breeding and yeast preparation is weak (R^2 of 0,31 and 0,36 respectively, see table 3). Second, the R^2 values of the models concerning antibiotic treatment as well as cis- and transgenic breeds are higher (0,49, 0,62 and 0,59), but their explanatory power depends primarily on the contribution of the willingness to consume. The beta weight for the expected effectiveness is highest in the model for classical breeding and smallest (though significant) in the transgenic breeds model. The correlation between the two explanatory factors is considerable in all models. As the models are just identified, no fit measures can be computed.

Figure 6 shows a mixed structural equation model including the attitude towards the cultivation of gm plants in general as a latent factor. The indicators for this factor (GA1 to GA3) consist of the degree of agreement with gm plant cultivation, the attitude towards the present moratorium prohibiting such cultivation, and the term for which the respondents would like it to be prolonged. All three indicators show that a large proportion of the respondents oppose the cultivation of gm plants.

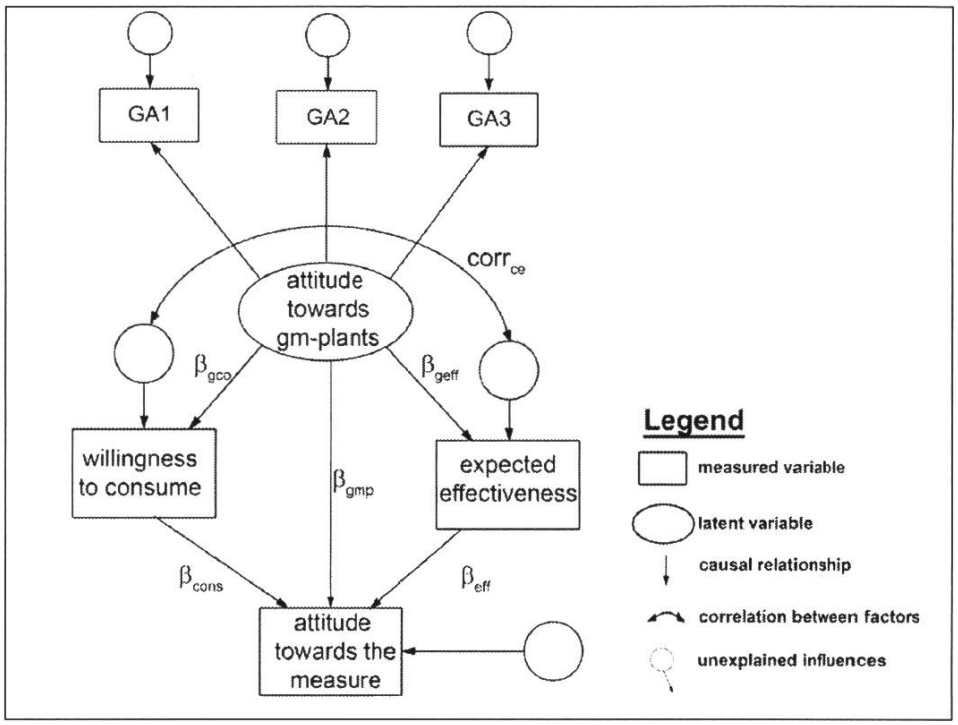


Fig. 6: Mixed model for the attitudes towards the measures against fire blight.

Tab. 4: Results of the mixed models for the attitudes towards the measures against fire blight

measures	**R^2**	**β_{cons}**	**β_{eff}**	**$corr_{ce}$**	**β_{gmp}**	**β_{gco}**	**β_{geff}**
antibiotic treatment	**0.50**	0.63***	0.11***	0.27***	0.10**	0.37***	0.10*
yeast preparation	**0.38**	0.47***	0.25***	0.31***	-0.15***	0.02 ns	-0.07 ns
traditional breeding	**0.35**	0.26***	0.37***	0.27***	-0.20***	-0.12**	-0.26***
cisgenic breeds	**0.66**	0.50***	0.14***	0.20***	0.29***	0.76***	0.26***
transgenic breeds	**0.65**	0.50***	0.08**	0.14**	0.34***	0.71***	0.21***

n=537
R^2: part of the variance in the attitude towards the attitude explained by the model
standardized results; levels of significance: ns = not significant; ** < .01; *** < .001

The latent factor is supposed to influence the attitude, as well as the two other factors, the willingness to consume and the expected effectiveness. It is significant not only in the models related to genetic engineering, but in all five models (table 4; see appendix 2 for measures of fit and non-standardized results). Furthermore, R^2 was improved in all models: most in the model for transgenic breeds and least - only marginally - in the model for antibiotic treatment. In the models for the cis- and transgenic breeds, the correlation between the willingness to consume and the expected effectiveness was considerably reduced, revealing the attitude towards gm plants in general as one of its sources.

For the antibiotic measure, the influences of the latent factor show the same directions as for the genetic engineering measures: The larger the acceptance of gm plants, the more positive the opinion about antibiotic treatment. This effect is largest on the willingness to consume. As the gm attitude can hardly be supposed to be a *cause* of the opinion regarding treatments with antibiotics, there must be some common cause to booster skepticism, such as concern about unknown consequences.

A negative attitude towards gm plants seems to increase the expected effectiveness of classical breeding. Comparing the models for traditional breeding and the cisgenic breeds, the respective beta weight is of the same size but with opposite sign. Please note: there is no significant correlation between the expected effectiveness of both measures. Therefore, the effect is not caused by the concrete gm measures framing the perception of classical breeding. Again, there seems to be some hidden factor connected to the gm attitude, such as a concept of "nature makes it best" and "the more natural - the more effective".

Splitting the sample along gender lines (table 5) confirms the main findings:

- There is little influence of the expected effectiveness on attitudes towards antibiotics and cis- or transgenic breeds. In the women's group, the influence of the effectiveness of transgenic breeds and antibiotics is not even significant. Men seem to put more weight on the expected effectiveness than women.
- The willingness to consume apples from a production applying antibiotics seems to be reduced by some factor also present in the concern against gm plants. A proportion of men seem to perceive such

a supposed "concern for unknown consequences," even for the application of a yeast preparation.

- The effect of the gm attitude in general (or a connected factor) on the expected effectiveness of classical breeding is present in both groups, but much more important in the men's group.

Tab. 5: Results of the mixed models, estimated separately for women and men

women (n=271)	R^2	β_{cons}	β_{eff}	$corr_{ce}$	β_{gmp}	β_{gco}	β_{geff}
antibiotic treatment	**0.50**	0.60***	0.09 ns	0.23***	0.18***	0.30***	0.17**
yeast preparation	**0.39**	0.49***	0.25***	0.29***	-0.06 ns	-0.08 ns	-0.09 ns
traditional breeding	**0.31**	0.25***	0.38***	0.34***	-0.11*	-0.18**	-0.15*
cisgenic breeds	**0.65**	0.54***	0.10*	0.20**	0.30***	0.71***	0.23***
transgenic breeds	**0.56**	0.35***	0.07 ns	0.04 ns	0.46***	0.67***	0.14*
men (n=266)	R^2	β_{cons}	β_{eff}	$corr_{ce}$	β_{gmp}	β_{gco}	β_{geff}
antibiotic treatment	**0.51**	0.65***	0.11*	0.32***	0.06 ns	0.37***	0.08 ns
yeast preparation	**0.38**	0.47***	0.26***	0.34***	-0.22***	0.13*	-0.01 ns
traditional breeding	**0.36**	0.28***	0.35***	0.23***	-0.23***	-0.02 ns	-0.31***
cisgenic breeds	**0.65**	0.48***	0.19***	0.20**	0.28***	0.79***	0.28***
transgenic breeds	**0.68**	0.60***	0.09*	0.22**	0.25***	0.71***	0.26***
levels of significance: ns = not significant; * < .05; ** < .01; *** < .001							

To sum up the results of modeling, figure 7 shows the phytosanitary measures grouped in controversial measures (gm breeds and antibiotics), and non-controversial measures (traditional breeding and yeast preparation). This distinction represents whether a clear majority of the

respondents stated negative or positive attitudes towards the measure. The parameters shown in figure 7 are the ones calculated without splitting the sample, but in addition, the sign of each significant parameter estimated for four sub-groups is indicated. The subgroups are defined by gender and by whether the respondents distinguish between the cis- and the transgenic cases (cis≠trans group), or not (cis=trans group). Thereby, some sensitivity of the relationships among criteria is shown: There is no reversal of signs between different groups.

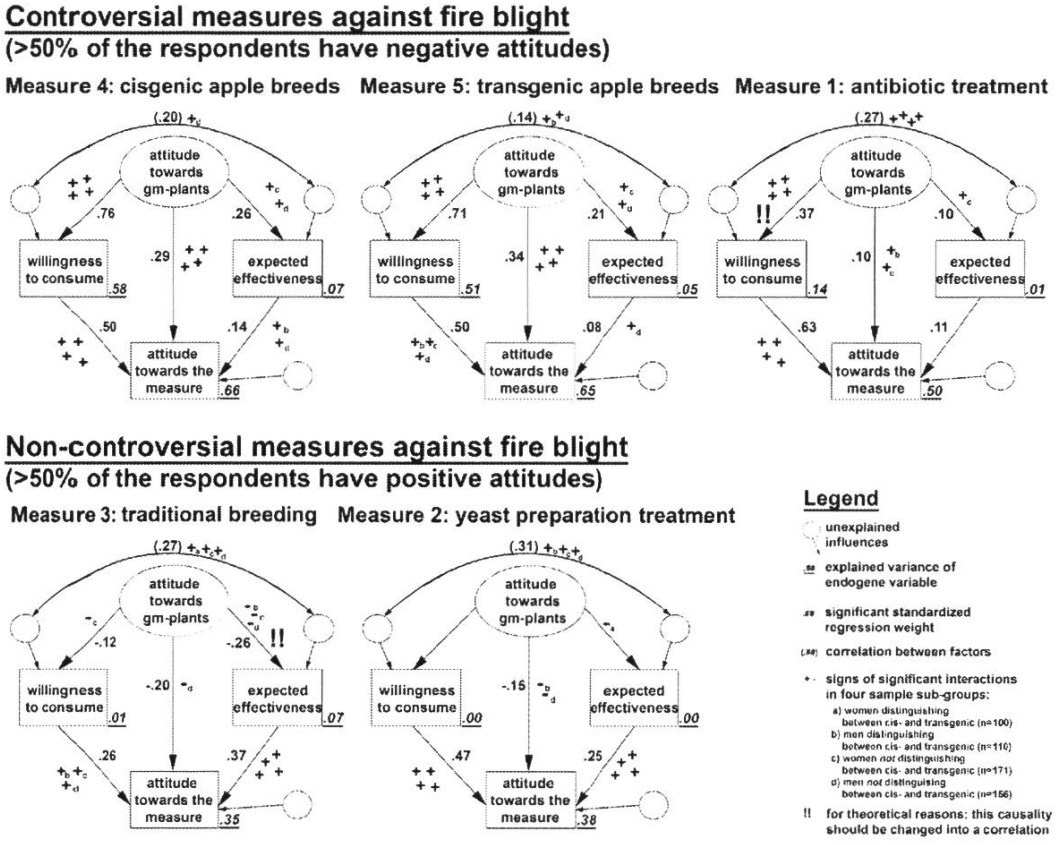


Fig. 7: Results for the models estimated for the sample (n=537) and its subgroups.

To summarize, our findings were as follows:

- For controversial measures, the influence of the expected effectiveness on the attitude is small and not stable over different groups of respondents. The model is dominated by the willingness to consume the apples (and factors of higher normative order, such as the attitude towards gm plants).

- For non-controversial measures, the effects of the expected effectiveness and the willingness to consume the apples are more balanced. However, a large proportion of the variance in the attitudes towards the measures is not explained by the models.
- The attitude towards gm-plants in general explains a large part of the variance in the willingness to consume gm-apples (cisgenic or transgenic). This attitude appears even to influence the willingness to consume apples produced with antibiotic treatment. As an interpretation, an underlying factor of concern about unknown consequences can be supposed to correlate with both the attitude towards gm-plants and the willingness to consume apples produced with antibiotic treatment.
- In the models for the non-controversial measures, the influence of the attitude towards gm plants is of minor importance and tends not to be stable over groups.
- For several measures, there was a tendency of the attitude towards gm plants in general to influence the expected effectiveness. However, the tendency was not stable over all groups of respondents. In the models for the genetic engineering measures, this relationship is significant only in the cis=trans groups. As a matter of fact, when excluding the halo-respondents from the sample, this influence becomes insignificant, as does the correlation between the expected effectiveness and the willingness to consume.
- In the model for classical breeding the apparent influence of the attitude towards gm plants in general should be interpreted to stem from a common underlying factor, influencing the attitude towards gm-plants and the expected effectiveness.

4. Conclusion

For respondents distinguishing cis- from transgenic, cisgenic apple breeds seem to be an option that is more acceptable than antibiotic treatment. However, cisgenic breeds are regarded to be less effective against fire blight, which could result from the difference in time frame. Still, the level of acceptance of antibiotic treatment does not appear to be very high. As the proportion of respondents with a negative stated

willingness to consume apples from production with antibiotic treatment is much larger than the market share of organic apples, the role of antibiotic treatments in non-organic apple production seems to be ignored by a large proportion of consumers. It is doubtful that the presence of cisgenic apples would be ignored in the same way. Therefore, an equivalent (or higher) amount of stated acceptance does not necessarily result in equivalent (or larger) revealed preferences.

Further, only 40 % percent of the respondents are ready to distinguish between cisgenic and transgenic apple breeds. In the population, the proportion must be expected to be even slightly lower because people with less education are underrepresented in our study's sample.

One difficulty when aiming to promote the acceptance of cis- or transgenic apple breeds is the weakness of the influence of the expected effectiveness on attitude. However, the same problem seems to be present in the perception of antibiotic treatment. In addition, the skepticism regarding antibiotic treatment seems to share some of its cognitive background with the skepticism regarding gm plants in general (e.g. higher perceived risks and little perceived naturalness, see SIEGRIST 2008).

The expected effectiveness seems to have a considerable effect on the attitudes only when judging measures that do not cause controversy. This finding appears clearly among the women's responses, whereas the men's responses show at least some tendencies for a link between the effectiveness of genetic engineering measures and the respective attitudes.

There seems to be an influence of the attitude towards gm plants on the expected effectiveness of cis- and transgenic breeds. However, this effect nearly disappears when the respondents who do not differentiate between criteria (halo-effect) are excluded. The proportion of the respondents showing such a response pattern increases with the proportion of opposition against the measure. Therefore, they can be supposed to be very strong opponents, unwilling to concede any positive attribute to the disliked object. For the remaining respondents, the main problem of acceptance is *not* that the technology lacks any benefit, but that its potential benefit is not important at all. Nevertheless, this must not be interpreted as a contradiction of GASKELL et al. (2006), who hypothesized the perceived absence of benefits as a major barrier to ac-

ceptance. As a large proportion of the respondents are quite confident that traditional breeding techniques will lead to a solution to combat fire blight, they might not feel any necessity to search for a more effective long-term measure.

These findings suggest that, when thinking about genetic engineering as offering possible future solutions to Swiss agriculture, cisgenic applications certainly are more likely to be accepted by the public than transgenic ones. Nonetheless, they would be controversial as well.

As this study used the context of fire blight to explore differences in the attitudes to cisgenic and transgenic plants, other frameworks should be used to gather further evidence. Also, the comparison of these attitudes should be extended to other explanatory factors such as perceived risks regarding health or environment. Additionally, the perceptions and beliefs that motivate or impede the differentiation in perception between cisgenic and transgenic breeds should be explored. Furthermore, the similarity of findings for antibiotic treatments of apple trees and the cultivation of gm breeds should be looked at more closely. Especially when investigating risk perception and the influence of trust, the comparison between the two promises to be interesting, one being legal, the other prohibited in the Swiss context.

References

BFS, (2009). Bildungsstand der Wohnbevölkerung nach Alter und Geschlecht. Neuchâtel: Bundesamt für Statistik.

BONFADELLI H., DAHINDEN U. and LEONARZ M,. (2007). Mass Media and Public Perception of Red and Green Biotechnology: A Case Study from Switzerland. In: BROSSARD D., SHANAHAN J. and NESBITT T.C. (Eds.): The Public, the Media and Agricultural Biotechnology. Oxon UK und Cambridge MA USA: CAB International, pp. 97-125.

BROOKES G. and BARFOOT P., (2005). GM Crops: The Global Economic an Environmental Impact - The First Nine Years 1996-2004. Journal of Agrobiotechnology Management and Economics Vol. 8, No. 2&3, pp. 187-196.

BUNDESRAT, (2006). Bundesratsbeschluss über das Ergebnis der Volksabstimmung vom 27. November 2005 (Volksinitiative «für Lebensmittel aus gentechnikfreier Landwirtschaft»; Änderung des Arbeitsgesetzes). Bundesratsbeschluss. BBl 2006 1061, 19. Januar 2006, Bern.

COOPER W.H., (1981). Ubiquitous Halo. Psychological Bulletin. Vol. 90, No. 2, pp. 218-244.

EAGLY A.H. and CHAIKEN S., (1993). The Psychology of Attitudes. Belmont CA, USA: Wadsworth Group / Thomson Learning.

EFSA and DG-SANCO, (2006). Special Eurobarometer: Risk Issues. European Food Safety Authority and European Commission Health and Consumer Protection Directorate General, Parma & Bruxelles.

GASKELL G., ALLANSDOTTIR A., ALLUM N. et al., (2006). Europeans and Biotechnology in 2005: Patterns and Trends. Eurobarometer 64.3. European Commission's Directorate-general for Research, May 2006.

GESSLER C. and PATOCCHI A., (2007). Recombinant DNA Technology in Apple. Advances in Biochemical Engineering / Biotechnology. Vol. 107, pp. 113-132.

HIMMELFARB S,. (1993). The Measurement of Attitudes. In: EAGLY A.H. and CHAIKEN S., (Eds.): The Psychology of Attitudes. Belmont CA, USA: Wadsworth Group / Thomson Learning, pp. 23-87.

IBANEZ A.M. and DANDEKAR A.M., (2007). Apple. In: PUA, E.-C. and DAVEY M.R., (Eds.): Biotechnology in Agriculture and Forestry, Volume 60: Transgenic Crops V. Berlin, Heidelberg: Springer.

JANN B., (2006). Der Berner Stichprobenplan. Ein Vorschlag für eine effiziente Klumpenstichprobe am Beispiel der Schweiz. ETH Zürich. http://www.socio.ethz.ch/people/jannb/wp/bernerstichprobenplan20060309.pdf. 30.07.2008.

JOCHEMSEN H., (2008). An Ethical Assessment of Cisgenesis in Breeding Late Blight Resistant Potato. Potato Research. Vol. 51, pp. 59-73.

KAHNEMAN D., (2003). A Perspective on Judgment and Choice: Mapping Bounded Rationality. American Psychologist. Vol. 58, No. 9, pp. 697-720.

KASSARDJIAN E., GAMBLE J., GUNSON A. and JAEGER S.R., (2005). A New Approach to Elicit Consumer's Willingness to Purchase Genetically Modified Apples. British Food Journal. Vol. 107, No. 8, pp. 541-555.

KLINE R. B., (2005). Principles and Practice of Structural Equation Modeling. 2nd Ed. New York, London: The Guilford Press.

KOLLER B., GESSLER C., BERTSCHINGER L. and KELLERHALS M., (1995). Technikfolgen des Einsatzes gentechnisch veränderter krankheitsresistenter Nutzpflanzen. Teil Apfel. Institut für Pflanzenwissenschaften der ETH Zürich & Eidgenössische Forschungsanstalt für Obst-, Wein- und Gartenbau Wädenswil.

KRENS F.A., PELGROM K.T.B., SCHAART J.G., DEN NIJS A.P.M. and ROUWENDAL G.J.A., (2004). Clean Vector Technology for Marker-free Transgenic Ornamentals. Acta Horticulturae. Vol. 651, pp. 101-105.

KROSNICK J.A., JUDD C.M. and WITTENBRINK B., (2005). The Measurement of Attitudes. In: ALBARRACÍN D., JOHNSON B.T. and ZANNA M.P., (Eds.). The Handbook of Attitudes. Mahwah N.J.: Lawrence Erlbaum Associates, pp. 21-76.

MERVIS C.B. and ROSCH E., (1981). Categorization of Natural Objects. Annual Review of Psychology. Vol. 32, pp. 89-115.

MORWITZ V.G., (1997). Why Consumers Don't Always Accurately Predict Their Own Future Behavior. Marketing Letters. Vol. 8, No. 1, pp. 57-70.

SIEGRIST M., (2000). The Influence of Trust and Perceptions of Risks and Benefits on the Acceptance of Gene Technology. Risk Analysis: An International Journal. Vol. 20, No. 2, pp. 195-204.

SIEGRIST M., (2003). Perception of Gene Technology, and Food Risks: Results of a Survey in Switzerland. Journal of Risk Research. Vol. 6, No. 1, pp. 45-60.

SIEGRIST M., (2008). Factors Influencing Public Acceptance of Innovative Food Technologies and Products. Trends in Food Science & Technology. Vol. 19, pp. 603-608.

VAECK M., REYNAERTS A., HÖFTE H. et al., (1987). Transgenic Plants Protected from Insect Attack. Nature. Vol. 328, No. 2, pp. 33-37.

Acknowledgements: The author would like to thank Bernard Lehmann, Robert Huber, Conradin Bolliger, Martijn Sonnevelt and two anonymous reviewers for their helpful comments and advice.

Appendix 1: Questionnaire

7. Feuerbrand: Ein aktuelles Problem

Das Problem

Der Feuerbrand ist eine von Bakterien verursachte Krankheit, die Apfelbäume und andere Kernobstbäume sowie verwandte Zier- und Wildpflanzen befällt. Die Krankheit ist äusserst ansteckend. Ursprünglich stammt sie aus Nordamerika. Im Jahr 2007 verbreitete sich der Feuerbrand in der Schweiz so stark wie noch nie. Obstproduzenten und Fachleute machen sich Sorgen um die zukünftige Entwicklung.

Mögliche Massnahmen

Antibiotika spritzen:

Das zur Bekämpfung des Feuerbrands verwendete Antibiotikum wurde 1943 als erstes wirksames Mittel gegen die Tuberkulose entdeckt, heute gilt es nur noch als Reservemedikament. Die Anwendung von Antibiotika ausserhalb der Humanmedizin ist aber generell umstritten. Es wird befürchtet, dies könnte die Entstehung resistenter Bakterienstämme beschleunigen. Daher ist der Einsatz von Antibiotika im Schweizer Obstbau nur unter strengen Auflagen erlaubt. Die Äpfel selbst enthalten keine Antibiotika.

Hefepräparat spritzen:

Als weiteres Spritzmittel steht ein Hefepräparat zur Verfügung. Es gilt als umweltverträglich und ist auch im Biolandbau zugelassen. Seine Wirkung ist allerdings weniger zuverlässig als diejenige des Antibiotikums und seine Anwendung relativ teuer. Bei mehrmaliger Anwendung führt es dazu, dass die Oberfläche der Früchte aufgeraut wird und sie ihre Farbe wechseln. Obwohl sich die Qualität solcher Äpfel nur äusserlich ändert, lassen sie sich kaum mehr als Tafeläpfel verkaufen.

Traditionelle Züchtung:

Es gibt Apfelsorten, die deutlich weniger anfällig auf Feuerbrand sind; jedoch ist keine völlig resistent dagegen. Die Kreuzung von eher widerstandsfähigen Sorten kann neue, noch widerstandsfähigere Sorten ergeben. Diese traditionelle Züchtung ist sehr zeitintensiv, für eine neue Sorte vergehen 15 bis 20 Jahre. Sie stellt in Bezug auf Geschmack, Haltbarkeit, Aussehen eine Mischung aus ihren Elternsorten dar. Wie diese Mischung genau ausfällt, bestimmt der Zufall mit.

Gentechnik, nur Apfel-Gene:

Mit Methoden der Gentechnik können gezielt neue Gene in eine Apfelsorte eingeführt werden. Wenn dieses Erbgut aus anderen Apfelsorten stammt, liegt der Hauptnutzen der Gentechnik in einer starken Beschleunigung und einer grösseren Kontrolle des Züchtungsvorgangs. Theoretisch könnte eine nahezu identische Apfelsorte auch durch eine viele Jahrzehnte dauernde, traditionelle Züchtung gewonnen werden. Der Anbau solcher gentechnisch veränderten Apfelbäume wäre in der Schweizer Landwirtschaft heute nicht erlaubt (wegen des Gentechmoratoriums).

Gentechnik, artfremde Gene:

Wenn einer Apfelsorte Gene aus anderen Pflanzen oder aus Bakterien usw. eingepflanzt werden können, nehmen die Möglichkeiten zu, Sorten zu finden, die eine sehr hohe Resistenz gegen Feuerbrand aufweisen. Kritiker sind aber der Meinung, dass transgene Pflanzen nicht abschätzbare Risiken für Umwelt und Konsumenten bergen. Der Anbau dieser gentechnisch veränderten Apfelbäume wäre in der Schweizer Landwirtschaft heute nicht erlaubt (wegen des Gentechmoratoriums).

Das Gentechmoratorium läuft noch bis Ende 2010. Der Bundesrat wird diese Frist um 3 Jahre verlängern.

Eine Pflanzenkrankheit, Antibiotika und Gentechnologie – ein schwieriges Thema. Links finden Sie einige Informationen.

	gar nicht wichtig 0	1	2	3	äusserst wichtig 4
7.1 Wie wichtig ist es aus Ihrer Sicht, den Feuerbrand zu bekämpfen?	☐	☐	☐	☐	☐

7.2 Wie schlimm finden Sie diese möglichen Folgen des Feuerbrands?	gar nicht schlimm 0	-1	-2	-3	äusserst schlimm -4
▪ Bauern verlieren Einkommen.	☐	☐	☐	☐	☐
▪ Hochstammbäume sind bedroht.	☐	☐	☐	☐	☐
▪ Es gibt weniger Schweizer Äpfel.	☐	☐	☐	☐	☐

7.3 Wie finden Sie diese Massnahmen insgesamt? (vgl. Beschreibung links)	sehr schlecht -2	-1	0	+1	sehr gut +2
Antibiotika spritzen:	☐	☐	☐	☐	☐
Hefepräparat spritzen:	☐	☐	☐	☐	☐
Traditionelle Züchtung:	☐	☐	☐	☐	☐
Gentechnik, nur Apfel-Gene:	☐	☐	☐	☐	☐
Gentechnik, artfremde Gene:	☐	☐	☐	☐	☐

7.4 Was glauben Sie, wie *wirksam* sind die Massnahmen insgesamt?	gar nicht wirksam 0	1	2	3	sehr wirksam 4
Antibiotika spritzen:	☐	☐	☐	☐	☐
Hefepräparat spritzen:	☐	☐	☐	☐	☐
Traditionelle Züchtung:	☐	☐	☐	☐	☐
Gentechnik, nur Apfel-Gene:	☐	☐	☐	☐	☐
Gentechnik, artfremde Gene:	☐	☐	☐	☐	☐

7.5 Würden Sie Äpfel kaufen und essen, von denen bekannt ist, dass sie aus solcher Produktion stammen?	sicher nein -2	-1	vielleicht 0	+1	sicher ja +2
Antibiotika gespritzt:	☐	☐	☐	☐	☐
Hefepräparat gespritzt:	☐	☐	☐	☐	☐
Traditionell gezüchtet:	☐	☐	☐	☐	☐
Gentechnik, nur Apfel-Gene:	☐	☐	☐	☐	☐
Gentechnik, artfremde Gene:	☐	☐	☐	☐	☐

Fig. 8: Fire blight section in the questionnaire (original).

Appendix 2: Fit indices and non-standardized solutions

Tab. 6: Fit indices for the mixed models, estimated without grouping

	DF	Chi2	p of Chi2	Chi2/DF	CFI	GFI	RMSEA	p of RMSEA
antibiotics	6	6.449	0.375	1.075	1.000	0.996	0.012	0.894
yeast	6	17.557	0.007	2.926	0.989	0.989	0.060	0.265
breeding	6	6.244	0.396	1.041	1.000	0.996	0.009	0.902
cisgenic	6	19.446	0.003	3.241	0.992	0.987	0.065	0.193
transgenic	6	28.332	0.000	4.722	0.987	0.982	0.083	0.032

Tab. 7: Fit indices for the mixed models, estimated separately for women and men

	DF	Chi2	p of Chi2	Chi2/DF	CFI	GFI	RMSEA	p of RMSEA
antibiotics	12	16.485	0.170	1.374	0.996	0.990	0.026	0.906
yeast	12	23.772	0.022	1.981	0.989	0.986	0.043	0.647
breeding	12	19.658	0.074	1.638	0.992	0.988	0.035	0.811
cisgenic	12	24.814	0.016	2.068	0.991	0.985	0.045	0.601
transgenic	12	35.715	0.000	2.976	0.985	0.979	0.061	0.197

Tab. 8: Mixed models, non-standardized solution, estimated without grouping (n=537)

explained variable	explaining variable	antibiotic	yeast	breeding	cisgenic	transgenic
willingness to consume	attitude towards gm plants	0.47***	0.03 ns	-0.08**	0.91***	0.75***
expected effectiveness	attitude towards gm plants	0.10*	-0.05 ns	-0.23***	0.28***	0.24***
GA1	attitude towards gm plants	1.00	1.00	1.00	1.00	1.00
GA2	attitude towards gm plants	0.93***	0.93***	0.94***	0.87***	0.86***
GA3	attitude towards gm plants	1.19***	1.20***	1.20***	1.11***	1.07***
attitude towards measure	attitude towards gm plants	0.11**	-0.14***	-0.16***	0.32***	0.31***
attitude towards measure	expected effectiveness	0.12***	0.31***	0.33***	0.15***	0.07**
attitude towards measure	willingness to consume	0.56***	0.44***	0.33***	0.46***	0.44***

Tab. 9: Mixed models, non-standardized solution, estimated for women only (n=271)

explained variable	explaining variable	antibiotic	yeast	breeding	cisgenic	transgenic
willingness to consume	attitude towards gm plants	0.51***	-0.11 ns	-0.14**	1.03***	0.75***
expected effectiveness	attitude towards gm plants	0.23***	-0.09 ns	-0.18*	0.33***	0.21*
GA1	attitude towards gm plants	1	1	1	1	1
GA2	attitude towards gm plants	1.02***	1.03***	1.03***	0.95***	0.91***
GA3	attitude towards gm plants	1.56***	1.51***	1.49***	1.33***	1.23***
attitude towards measure	attitude towards gm plants	0.28***	-0.09 ns	-0.11*	0.40***	0.46***
attitude towards measure	expected effectiveness	0.10 ns	0.34***	0.33***	0.09*	0.05 ns
attitude towards measure	willingness to consume	0.56***	0.46***	0.33*	0.50***	0.31***

Tab. 10: Mixed models, non-standardized solution, estimated for men only (n=266)

explained variable	explaining variable	antibiotic	yeast	breeding	cisgenic	transgenic
willingness to consume	attitude towards gm plants	0.42***	0.12*	-0.02 ns	0.87***	0.74***
expected effectiveness	attitude towards gm plants	0.07 ns	-0.01 ns	-0.25***	0.26***	0.25***
GA1	attitude towards gm plants	1	1	1	1	1
GA2	attitude towards gm plants	0.91***	0.91***	0.92***	0.85***	0.85***
GA3	attitude towards gm plants	1.07***	1.08***	1.08***	1.01***	0.99***
attitude towards measure	attitude towards gm plants	0.06 ns	-0.18***	-0.17***	0.30***	0.22***
attitude towards measure	expected effectiveness	0.12*	0.30***	0.33***	0.20***	0.08*
attitude towards measure	willingness to consume	0.56***	0.43***	0.34***	0.43***	0.52***

Kontaktautorin:

ETH Zurich
Institute for Environmental Decisions IED
Agricultural Economics - Agri-food & Agri-environmental Economics
Group AFEE
Therese Haller
Sonneggstr. 33; SOL D6
CH-8092 Zürich

Email: thhaller@ethz.ch