Ethical Compatibility of GM Crops with Intrinsic and Extrinsic Values of Farmers: A Review

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Abstract: The role of intrinsic and extrinsic ethical values as determinants of farmers' adoption decisions of genetically modified (GM) crops is reviewed based on 17 scientific papers publish between 1999 and 2006 in nine countries. In these studies, intrinsic values received less attention than extrinsic values as contributors to adoption decisions. The naturalness/unnaturalness concept featured only in one qualitative study. Farmers in most countries were generally very knowledgeable about issues related to GM food safety, environmental and agronomic impacts, and animal welfare. In a study conducted in New Zealand, farmers intending to adopt GM crops agreed more with the anthropocentric value position than other conventional or organic farmers, who tended to emphasize the risks associated with GM crops. This and other farmer typologies, produced in four countries on the basis of expressed ethical attitudes toward GM crops and condensing around benefit believers, risk perceivers and fatalists, showed recognizable consistency between countries. Thus conventional farmers are far from being a homogeneous group in regard to their attitudes toward GM crops. Even those who were using these crops for years questioned and evaluated their decision continuously. Despite the expressed ethical concerns, economic and market considerations tended to figure as the most prominent determinants of intended or realized adoption/rejection decisions. The stability/changeability of farmers' ethical values in the course of the innovation-adoption process is discussed. The term ethical compatibility is suggested to be included in the list of innovation attributes as used according to the adoption perception paradigm of innovation diffusion research.

Key Words: Farmers, ethics, intrinsic values, extrinsic values, transgenic crops, genetically modified crops, genetic engineering, biotechnology, agriculture, innovation diffusion, innovation adoption, attitudes, theory of planned behavior.

INTRODUCTION

The five major aspects of biotechnology ethics are (i) food safety, (ii) animal welfare, (iii) environmental impacts, (iv) social consequences, and (v) the naturalness/ unnaturalness issue [1, 2]. In the past decade several authors have considered the ethics of biotechnology in agriculture, especially the development, adoption and regulation of transgenic crops [1, 3-13]. In their survey of the multitude of academic papers concerning the ethics, economics and social impacts of genetically modified (GM) crops, White and Veeman [14] included only five papers linked with the word farmer or grower. Such absence of the farmer perspective from the ethical discourse of biotechnology has been noted also by Mauro and McLachlan [15] and Hall [16]. A common argument about consumer choice is that they must not be put in a position where they are unable to apply their own values in choosing whether to eat the products of biotechnology [17]. Such arguments are less frequently expressed about conventional farmers.

The farmer's perspective on the ethics of adopting new technologies was addressed by Mepham [18] and Gesche and Haslberger [19] in developing tools for policy-makers investigating the consequences to different stakeholders of a particular technology. In the ethical tool [19], the farmers' perspective on the adoption of GM crops included the following: income security and sustainable agricultural practices (the beneficence principle), dependence on the strategies of biotechnology corporations and loss of traditional landraces (the non-maleficence principle); fair treatment in trade and law, as well as respecting local values and traditions (the principle of justice and fairness); and freedom to adopt or not to adopt the new technology (autonomy, choice and self-determination, i.e. respect toward autonomy). This is a fair start, but fails to convey the personal experience of the complexity of the combined technical, ethical, social, and business environments in which a farmer makes the decision whether to adopt or reject GM crops [20-22].

Farmers are potentially subject to influence from both sides of the GMO (genetically modified organism) debate: encouraged by the agrobiotech industry to adopt the new technology, targeted by protest groups intent on destroying crops, and facing potential consumer and supermarket rejection of GM food [16]. In this tug of war, the farmer tries to meet and respond to the demands of agricultural, environmental, business and consumer ethics, often constrained in his ethical choices by the economic challenges created by industrialized agriculture [21, 20, 23]. In the midst of all this, the conventional farmer's individual and socio-cultural identity is challenged. The concept of a good farmer still

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revolves around the productivist paradigm, the myth of the garden (i.e. the farmer as steward responsible for the land and the tended landscape), hard work, and the doctrine of grace [24-26]. Gasson [27], Willock *et al*. [28] and Schoon and Te Groetenhuis [29] are referred to for original studies and Garforth and Rehman [30] for a review on general values of farmers. Often, the farmer finds himself defending his occupation. Whereas, the general public in Europe sees the three main responsibilities of farmers as (i) supplying the population with healthy and safe food; (ii) protecting the environment; and (iii) supplying the population with a diversity of quality products – and all this for reasonable prices [31].

The aim of this paper is to review the literature accumulated during the last 10 years on ethical issues of GM crops from the farmer perspective. We are particularly interested whether ethical values, either intrinsic or extrinsic, guide the adoption/non-adoption decisions of farmers. The review focuses on conventional farmers in developed countries, but studies contrasting conventional and organic farmers are used when available. We start by introducing the concepts of intrinsic and extrinsic values, then give a short overview of general values of farmers to build the framework in which intrinsic and extrinsic ethical values are considered as partial determinants of farmers' perceptions and attitudes toward GM crops. The Theory of Reasoned Action and the Theory of Planned Behavior are briefly introduced to illustrate how the antecedents of value-derived (and other types of) behaviour are elicited from individuals. Finally, we try to provide answers to two research questions on the basis of the 17 papers that were chosen as the material for this review: 1) to what extent are farmers guided by intrinsic and extrinsic values, leaving aside for the moment economic and financial considerations, in deciding whether to adopt GM crops; and 2) do the available studies reveal anything about the extent to which the principles of beneficence, non-maleficence, fairness and justice, and choice and self-determination are realized in the practice of farmers' using of GM crops?

INTRINSIC AND EXTRINSIC ETHICAL VALUES

Renner [32, p. 17] defines values as cognitive constructs that explain an individual's preferences in life goals, principles, and behavioural priorities. Values are formed and modified by an individual's experiences over her lifetime [33]. Their antecedents can be found in biology, race/ethnicity and gender, social structure (occupation, education, within-nation value systems, family characteristics, age cohort, and religion) [34]. People may not be aware of explicit reasons for the values they hold, but despite this they have implicit beliefs that contribute to value importance [35] in [30, 34].

The ethical problem facing a farmer is whether to adopt or reject GM crops considering the nature of the technology and knowledge of its relative benefits and risks. In ethical sense, the farmer is faced with a decision-problem [36, p. 30] where the ethical principles and values possessed by the farmer may suggest to him more than one alternative choice. Chouinard *et al.* [37], after reviewing the literature on utility and behavioral economics, conclude that it seems reasonable to assume that both egoistic-financial and social-moral factors may influence production decisions of farmers. In fact, they propose a model of three types of farmers that differ in their motivation toward adopting environmentally benign farming practices: those motivated by profit-maximizing, ego-utility maximizers, and a blend of ego- and steward-utility maximizers. Thus farmers may be motivated by both self and social interests when it comes to selecting farming practices. Much of the literature has sidestepped a systematic integration of self-interest and social goals, either by assuming that only profits matter, or by adding social and stewardship factors in an *ad hoc* way [37]. Such attitude seems to prevail also about conventional farmers' motivations regarding their adoption of GM crops.

The farmer's manifest behaviour (i.e. decision regarding GM crop adoption) is the product of his decision-making process that is relative to his value orientation [38]. A decision-making problem includes both economic, technical, social, political and ethical issues (see [33]). Of these, the economic, technical and social domains are included, in one form or another, in the determinants of the innovation-decision process illustrated by Rogers [39] (p. 170). The explicit ethical (and also political) dimensions are, however, lacking from the model. Fritzsche [33], in his graphical model, opens up the ethical decision-making dimension and shows how the initial influence upon decision-making stems from the individual's personal values of either instrumental (extrinsic) or terminal (intrinsic) in nature, and how these values are modified by several factors during the decision-making. The model is developed for the sphere of business ethics, where, of course, also farmers, as entrepreneurs, belong. In professional life external forces can mediate or alter personal values in decision-making [33]. Although a person's value system ranks values according to their relative importance to the individual [40], in a situation of constrained choice individuals may end up making trade-offs between their values [20, 23, 30]. Thus ethics, as practiced by farmers when facing an ethical problem, are not necessarily stable but are influenced by situational factors. Hendrickson and James [20] emphasize the understanding of the situational components that influence farmers' ethical behaviour, as farmers' activities influence society's access to such important public goods as good, safe food, and clean environment.

Ethical values are basic convictions about what is morally right and wrong, good and bad [41]. The intrinsic values have a central position in ethics [42]. Intrinsic values are ends in themselves, i.e. pursued for their own sake. The intrinsic value of something is said to be the value that that thing has "in itself," "for its own sake," "as such," or "in its own right."[42]. For example, the intrinsic value of plants indicates that a plant is ethically relevant and has a value in its own right, independent of its instrumental, or extrinsic, value to humans [43]. The intrinsic value attributed to environmental goods (e.g. a nature habitat) is associated with such attributes as nonsubstitutibility (uniqueness), irreversibility (replication of the specific commodity is impossible if it is destroyed), feelings of sentimentality, and a sense of moral obligation [44]. Thus a nature habitat can be valued because of characteristics it possesses in its own right, not because a walk in the forest or in a bog is enjoyable for a human being. Intrinsic values can be further categorised to high and low values and strong and weak values, for example. High values are values that are attributed to things that

make life flourishing (such as friendship); low values are connected to more basic issues. Strong values are typically attributed to things necessary for decent life (such as not having pain), whereas weak values are less important in this manner. Interestingly strong values are often low values and weak values are high values. Since food production contributes into feeding people it seems to be somehow associated with strong and low values – and even more clearly with extrinsic values. Nevertheless, as views about good food and the way it is produced are connected to many intrinsic values including fairness, health, pleasure etc., ethical questions about food production may also concern high values. The antithesis of naturalness/unnaturalness, for example, is central in the sphere of high intrinsic values in the arguments of GMO opponents [1] (p. 183-184). According to Siipi [45], the terms natural/unnatural are ambiguous, and rather than discussing naturalness and unnaturalness in general, the different forms of (un)naturalness should be the focus of discussion. On the other hand, it can be asked why something that is unnatural should be considered as being also unethical? [17].

Comstock [1] lists 14 ways that opponents of genetic engineering (GE) and GMOs have used when defending their position on GE of plants, animals, and foods being unnatural. This can mean playing God, arrogating historically unprecedented power to ourselves, exhibiting arrogance, hubris, and disaffection, messing up with the essence of living beings by crossing species boundaries, changing telos, or end, of an a individual, commodifying life and disrespecting life by e.g. patenting it, and disrupting the integrity, beauty, and balance of creation. Intrinsic objections typically rely on ethical claims that do not fall into an overlapping consensus, and the same concerns their rejection, according to Seifert and Hedemann [46]. Intrinsic objections thus cannot be appealed to in justifying e.g. GM food policy, but on the other hand public policy concerning GMOs should also not be justified on grounds that require the rejection of intrinsic objections [46].

Extrinsic value is value that is not intrinsic. That which is extrinsically good/bad is derivatively good/bad; it is good/bad, not for its own sake, but for the sake of something else that is good/bad and to which it is related in some way [42]. There is a general agreement on the usefulness of the distinction between intrinsic and extrinsic values, but the difficulty lies in where exactly to draw the line between them [47] (p. 114). Especially the distinction between strong intrinsic values and extrinsic values is often hard to make. Often, the one and same thing can be valued both intrinsically and extrinsically. When a nature habitat is threatened to be destroyed, are we concerned for the habitat's own sake (intrinsic value attributed to the habitat), or because we may lose the possibility of walking in that particular habitat forever (extrinsic value attributed to the habitat)? [48]. The latter is an anthropocentric, utility-based view on nature. Viewed in this light, GM crops have (positive) extrinsic value if they bring benefits to the humankind, animals and ecosystems (e.g. [49, 50]). The opponents of GMOs tend to argue that GMOs have harmful (extrinsic) consequences of basically five different general types: i) impact on the environment (impacts that could disrupt ecosystem processes, escape of rDNA genes to wild plants and weeds *via* pollen flow, loss of GE traits by way of target pest developing resistance to them); ii) impact on humans, including food safety; iii) impact on non-human animals; iv) impact on farming communities in both the developed and developing countries; and v) shifting power relations (e.g. the rising importance of commercial interests and multinationals and farmers becoming dependent on the GM seeds produced by such companies). [1, 17]. The alleged risks of GMOs may threaten things that are valued by humans either intrinsically or extrinsically, but not all humans share similar values toward the above things, or they perceive the relative importance of benefits to risks in different ways. For example, unintended ecological consequences of GMOs receive different level of concern in Europe and North America. Americans and Canadians have not historically associated ecological risks of agricultural biotechnology with ethical concern ([17] and references therein). The alleged extrinsic risks, i.e. possible unintended consequences of GMOs, are anticipated and managed with risk analysis comprising risk identification, measurement, evaluation, and management. Thompson [17] argues it is possible to see all phases of risk analysis as involving ethical issues. Value judgments are implicit in attempts to identify or decide which consequences are relevant, determine which of the possible courses of action should be selected for modelling and analysis, to choose how to treat uncertainties in data and modelling, and how to derive and integrate statistical and subjective probabilities [17].

HOW ARE VALUES CAPTURED?

Values can be understood as a group-level phenomenon requiring shared agreement, but they are more typically understood and measured or captured as an individual-level construct [34]. Qualitative studies employ several different techniques to elicit antecedents of behaviour (values, beliefs, attitudes, intentions) from individuals (see Table **1** for definitions). Qualitative techniques include structured and open-ended in-depth interviews followed by discourse or content analysis, focus group work-shops (for an illustrative example, see [51]) or panels with group-laddering interviews and content analysis. Such techniques probe into the internal structure of participants' belief systems, and usually leave the interviewee much more space to formulate his or her ideas than would be possible in a quantitative survey [52] (p. 22-23).

On the other hand, the quantitative, behavioural approach is based on a cognitive construct model involving attitudes as the main antecedents of behaviour. Such expectancy-value-based models of attitude-behavior relationships aim at predicting the decision-making behaviour of the studied population, or at explaining the non-economic factors which contribute to decision-making. In such models, attitude toward a behaviour (e.g. adoption of GM crops by a farmer) is itself a function of the value one assigns to the perceived *consequences* of the behaviour ("What follows if I adopt GM crops, or decide not to adopt, or postpone adoption, or adopt only on a portion of my acreage now?") and the subjective probabilities one attaches to those consequences. In essence, the structure of these models reflects the subjective expected utility that underpins people's choices; as such, they are rational choice models of human behaviour [53]. There are two frequently applied theories of this approach, the Theory of

Table 1. Definitions of Key Cognitive Constructs of the Behavioural Approach to Elicit the Antecedents of Behavior

Term	Definition	Reference
Value	Enduring beliefs that specific modes of conduct or end-state of existence are personally or socially preferable to some opposite or converse modes of conduct or end–states of existence. Criteria that people use to select and justify actions and to evaluate events and themselves, as well as other people.	[38] [40], p. 551
Perception	A way of conceiving something. Perception is the way people organize and interpret the world around them in order to give meaning to their surroundings.	http://wordnetweb.princeton.edu/perl/webwn?s=perception [41]
Belief	Conviction that tends to originate from values but is not necessarily always based on reflection and conscious objective thinking. Any cognitive content held as true.	[30] http://wordnetweb.princeton.edu/perl/webwn?s=belief
Attitude	Favourable or unfavourable disposition susceptible to transient influences. A complex mental state involving beliefs, feelings, values and dispositions to act in certain ways.	[30] http://wordnetweb.princeton.edu/perl/webwn?s=attitude
Intention	An anticipated outcome that is intended or that guides your planned actions.	http://wordnetweb.princeton.edu/perl/webwn?s=intention
Goal	The state of affairs that a plan is intended to achieve and that (when achieved) terminates behavior intended to achieve it.	http://wordnetweb.princeton.edu/perl/webwn?s=goal
Objective	The goal (aim) intended to be attained (and which is believed to be attainable).	http://wordnetweb.princeton.edu/perl/webwn?s=objective

Reasoned Action (TRA) and its more advanced version, the Theory of Planned Behavior (TBP) [54-56]. According to these theories, attitudes are transferred to behaviours *via* intention, the proximal cause of behaviour (Fig. **1**). Not all attitudes are value-expressive [57], but for cases when they are assumed to be, empirical evidence confirms the causal link (e.g. [58]). Once the model has been specified and the different components operationalized as statements concerning behavioural antecedents and outcomes, respondents' responses toward the statements are captured by questionnaire surveys, whereupon the respondents express their evaluation of statements on a Likert-scale (agreement-disagreement with or favourableness-unfavourableness of the stated issue) [59].

Sparks *et al*. [60] state that attitudes may arise partly as a consequence of the outcomes being unknown. This means that perceptions of *uncertainty* about outcomes rather than beliefs about particular outcomes might provide the dominant influence on attitudes [60]. For farmers contemplating the adoption of GM crops, such uncertainty is one of the reasons that accentuates his ethical dilemma: The farmer may have to decide about adoption or rejection of GM crops before they know enough about all potential benefits and risks of the technology. In such a situation farmers are dependent on the information given to them by various sources, the trustworthiness of which may be perceived variably by the farmer. Attitudes can be assumed to change over time when diffusion proceeds, resulting in decrease of uncertainty owing to increased experience and knowledge about the technology (see [39], p. 20-21). The Elaboration Likelihood Model can be used to systematically investigate the impact of information on attitude change [59, 61].

TPB has been shown to be efficacious as a predictor of intentions and behaviour [54]. The behavioural approach is much used in agricultural studies, although not always in a valid way [62]. Bredahl *et al*. [59] reviewed literature on attitudinal-behavioral models and modified TPB to include components they deemed necessary for studies focusing on consumer attitudes regarding GM foods. The same modifications are probably applicable also for studies on farmers' attitudes regarding GM crop adoption and use. Additional components can be added to the model if they influence behaviour and beliefs of its outcomes independently of attitudes [59]. Such components include: i)subjective norms that incorporate the person's beliefs concerning what significant others (farmer's family members, other farmers, other stakeholders) think about his choices; ii) perceived behavioural control (PBC); iii) self-identity (the global understanding a sentient being has of him or her; as such, this component incorporates also personal norms); and iv) the component of perceived ethical/moral obligations. Of these components, PBC expresses the perceived difficulty that covers factors embedded in the person such as skills and abilities to realize the (intended) behaviour of interest, and perceived control that covers the effect of external factors believed by the farmer to influence the degree of personal control over the behaviour in question ("Do I get non-GM seeds from anywhere if I decide not to plant GM-crops?"). The competence that a farmer feels he or she has in judging risks and benefits of a GM crop in a choice situation is an important aspect of PBC [59].

In the TPB model, the importance of the measure of ethical/moral obligation stems from the 'social' context of the attitude-behaviour studies. In other words, behaviours may not be of a purely self-interested nature unlike predicted by the original TPB model, but decision-making may be driven also by a sense of ethical obligation and self-identity, in contrast to being driven by only attitudes that are deemed to stem from behavioural beliefs and outcome evaluations (e.g. [63]). For example, individuals may want to preserve a natu-

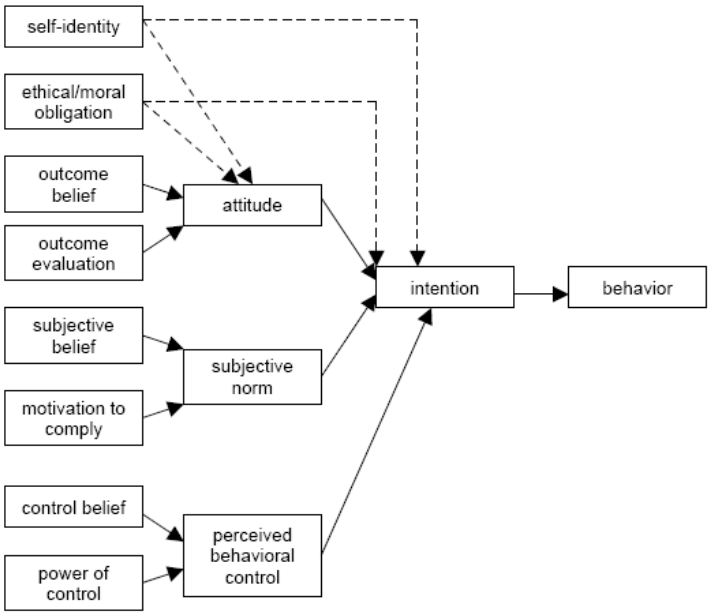

Fig. (1). Schematic representation of the Theory of Planned Behaviour and its components influencing intention and/or attitude. Adapted from Garforth and Rehman [65]. The ethical/moral obligation component and self-identity component have been shown to influence intention either directly or *via* attitude (dashed lines) (see text for references).

ral resource for moral or other motives even if they know that they will never receive direct consumption benefits (use value) from it [37]. The independent impact of perceived ethical/moral obligation on behavioural intentions has been verified for intentions with regard to GM foods [60]; see also [56] (p. 199-200); [63]. However in two other studies this ethical component was deemed not to influence behaviour or intentions directly, but as an antecedent of attitudes [53, 64]. Where in the model this component should be positioned may depend, for example, on what behaviour is in question and how other components have been operationalized [53, 60].

Where should intrinsic and extrinsic values expressed by the respondents toward the outcomes of the behaviour of interest be included in the model? We could not find any studies where this question was dealt with explicitly. Another question is whether intrinsic and extrinsic values can be incorporated in the one and same ethical/moral component, or whether they must be split indifferent components. Sparks *et al*. [60] in their study of consumer attitudes toward GM foods suggest that respondents' ratings on the measures of perceived ethical obligation may have been made as a proxy for instrumental considerations not provided for in the belief statements that were presented to subjects. This suggests that at least partly, the extrinsic values contributing to behavioural intentions may be incorporated in the statements describing the beliefs of the outcomes of the behaviour in question. Whereas other perceived ethical obligations (for example, in relation to "playing God" or "tampering with nature" with GMOs) may not be consequentialist or outcome-oriented in this way [60] and should be placed elsewhere (the self-identity component perhaps, or the component of ethical/moral obligations).

Bredahl *et al*. [59] suggest several modifications to the original TPB model for studying consumer attitudes toward GM food and attitude change. They propose that a distinction between different outcome types be made, as it may be that the beliefs underlying attitudes vary in strength depending on which outcome type the person has in mind. The beliefs underlying attitudes should be explicitly related to key outcome types so that the influences of each group on overall attitudes can be assessed. Beliefs about the risks and benefits of genetic engineering are important determinants of attitudes and it is recommended that an explicit distinction between beliefs of risks and beliefs of benefits associated with the application of genetic engineering should be made [59].

THE ROLE OF INTRINSIC AND EXTRINSIC VALUES IN FARMERS' DECISION-MAKING REGARDING GM CROPS: A LITERATURE REVIEW

Collection of Material and General Overview of Farmer Attitudes Toward GM Crops

The collection of the review material was started using the following search words and phrases in ISI Web of Science, CAB Abstracts, and Google Scholar: farmer/grower ethics; ethics + transgenic crops /biotechnology /genetically modified crops /gmo crop; farmer/grower ethics + genetically modified crop/gmo/transgenic crop /biotechnology; farmer/"grower + attitude/perception/belief/intention + genetically modified crop/gmo/transgenic crop /biotechnology. Further searches were based on reference lists of found papers, and on papers citing found papers and, again, the reference list of the former. This searching procedure,

complemented with *ad hoc* searches using various combinations of the above search words, yielded a total of 17 papers that reported studies in which farmers' values, beliefs, perceptions, attitudes and behaviour with regard to the adoption, use and acceptability of GM crops either been surveyed using structured questionnaires or qualitative interviews, or a combination of both methods. In terms of serving as guides to farmers' values on GM crops, the methodological rigour of the studies varied considerably (Table **2**).

Table **3** presents an overview on the willingness of farmers to adopt GM crops as percentages of farmer respondents. This is just a starting point to show the variability in farmer attitudes, because yes-no responses give no indication whether ethics were involved in generating the responses, or whether they reflect mere economical, technical, political and social value positions. This table suggests that experience increases farmers' willingness to use GM crops and reduces the farmers' uncertainty to adopt. Such a trend is in accordance with the innovation diffusion theory which states that uncertainty diminishes over time through the acquisition of experience and information [39, 80]. In Ohio, Napier *et al*. [73] reported that experience and information significantly increased the acceptance of GE of plants by rural inhabitants compared to urban citizens. In Illinois, farmers with experience in growing GM crops were more likely to agree upon benefits and ethicality of biotechnology in both plant and animal production [79]. Thus experience may count as a necessary, but apparently not as a sufficient condition for improved attitude toward GM crops. Mauro *et al*. [75] report that the Canadian farmers' experience on herbicide tolerant canola did not prepare ground for their acceptance of Roundup Ready wheat (RRW). The reasons for rejecting RRW were pragmatic in contrast to consumers who tend to evaluate the desirability of biotechnology according to ideology and concern regarding human and environmental health [75].

Table 2. Papers Included in the Review. Pre/Post = Study was Conducted Before/After GM Crops were Available for Growing. QQS=Quantitative Questionnaire Survey

Year of Study	Country (State)	Methodology. Theoretical Approach for Eliciting Values, Perceptions, Attitudes, or Intentions. Data Analysis	Reference
1999 pre	AU	QQS, 193 respondents. No theory explicitly stated. Regression, Chi-square test, correlation.	[66]
1999 pre	NO	QQS, 430 organic and 383 conventional farmer respondents. No theory explicitly stated. Binary logistic regression.	[67]
2000 pre	NZ	QQS, 656 respondents. None eplicitly stated, Theory of Reasoned Action is implied. t-test.	[68]
2002 pre	NZ	QQS, 115 respondents. Theory of Planned Behavior. t-test, correlation, MANOVA.	[69]
2002 pre	US (WA)	QQS, 598 respondents (109 organic, 489 conventional). Libertarian, utilitarian and virtue traditions of ethics. Cross-tabulation.	[70]
2002 and/or afterwards post	ES	Qualitative techniques, 22 group and individual in-depth interview with farmers. Action research approach. Discourse analysis.	[71]
2002-03 post	CA	Mixed methodology with a QQS, 370 survey respondents, 15 in-depth face-to-face and 74 telephone interviews. Risk perception theory is suggested by the research approach. Correspondence analysis.	[15]
2003 post	US (MO)	Ethnographic open-ended interviews with two dozens of conventional farmers. No theory specified. Overall impressions on the content of the interviews.	[72]
2003 post	US (OH)	QQS, 902 respondents (43.7% farmers). Selected components of classical diffusion model and risk perception theory. Structural equation modelling.	[73]
2003 pre	AU	QQS, 71 respondents. Innovation adoption model. Discriminatory power scores.	[74]
2004 pre	CA	QQS, 1566 respondents. No theory explicitly stated, the research approach implies risk perception theory. Factor analysis; qualitative data was coded and any emerging themes identified were matched with quantitative findings.	[75]
2004 pre	IN	100 face-to-face interviews with open- and close-ended questions. Risk perception theory that included a component of moral aspects of the risk. Thematic content analysis.	[76]
2005 post	US (IL)	20 open-ended interviews, QQS of 200 adopters and non-adopters of Roundup Ready soya. No theory explicitly stated, but risk perception theory is implied. Discourse analysis (interviews), ordered logistic regression (mail survey).	[77]
2005 pre	GB (Scotland)	QQS using Q-methodology, face-to-face interviews, number of respondents not given. Analysis with PQ-Method (correlation, factor analysis, varimax rotation)	[16]
2005 pre	SE	QQS, 685 respondents. No theory explicitly stated. Correlation analyses, non-parametric tests, detrended correspondence analysis, principal component analysis.	[78]
2006 post	US	QQS, 692 respondents. Descriptive ethics. Principal component analysis.	[21]
Between 2003-05? post	US (IL)	QQS, 134 respondents. No theory explicitly stated, adopter perception paradigm with ethical compatibility as an attribute of the innovation is implied. Chi-square tests, factor analysis, binary logistic regression.	[79]

Table 3. Farmers' Interest States Regarding Adoption or Consumption of GMOs in Selected Countries in Pre- and Post-Release Situations

Country: Intention Regarding GMOs, Pre- or Post-Release Situation	% Yes (Agree)	% Neutral/ Doesn't Know	% no (Disagree)	Reference
CA: Would adopt Roundup Ready wheat? pre-release	not given	not given	89.8	[75]
SE: Would adopt? Insect resistant crops, pre-release	12.7	30.6	56.7	[78]
NZ: Would purchase GM food for consumption? pre-release	17	40	45	[69]
AU: Would grow GM canola? pre-release[1]	19	36	45	[81] (referred to in [74])
NZ: Would adopt? Crop not specified, pre-release	25	34	41	[69]
AU: Would accept? Pork with human gene, pre-release	25	13	62	[66]
AU: Would accept? Tomato with fish gene, pre-release	30	15	54	[66]
US (WA), farmers with organic crops: Would adopt? (crop not specified) , pre-/post-release[1]	30.2	29.7	40	[82]
AU: Would grow GM canola? pre-release	37	0	63	[74]
US (WA): Would adopt? (crop not specified) pre-/post-release[1]	41.8	32.7	25.5	[82]
ES: Would adopt Bt-corn? post-release	56	not given	not given	[83]
AU: Would accept? Better tasting tomato/blue rose /cheese produced with modified enzymes, pre-release	47-58	14-16	27-36	[66]
AU: Would accept? Herbicide resistant wheat, pre-release	63	14	23	[66]
US (OH): Is it ethically acceptable to genetically modify plants? (crop not specified), post-release	64.3	17	18.7	[73]
AU: Would consume flour of higher-yielding/pest resistant/herbicide resistant GM wheat? pre-release	71	12	17	[66]
AU: Would accept ? Blowfly resistant sheep, pre-release	72	11	16	[66]
AU: Would grow of higher-yielding/pest resistant/herbicide resistant clover or lupin? pre-release	62-84	6-14	11-23	[66]
US (IL): Will plant next year? (crop not specified), post-release	92.5	0	7.5	[79]

[1]At the time of the survey, GM corn, soybeans, cotton and potato were available, but these crops were grown only to a very limited degree in WA; the study therefore measured farmers' hypothetical interest in GM crops.

Role of Intrinsic Values in Adoption Decision-Making

Only few papers inquired into the intrinsic values of farmers regarding GM crops. Fairweather and Campbell [68] studied the intrinsic environmental beliefs of New Zealand farmers by contrasting organic, conventional and GE intending farmers. The two former groups had an unfavourable attitude towards GE, the organic farmers slightly, but not significantly, more so. The latter are committed to intensive production methods for which GM crops are potentially important. Farmers were presented with four value positions: anthropocentrism, deep ecology, ecofeminism and ecocentrism, and were asked to provide responses to a number of operational statements expressing these value positions. The three latter value positions all place intrinsic value on nature, whereas anthropocentrism values nature only because of material or physical benefits it can provide for humans. Although there were no clear *qualitative* differences in the intrinsic value positions of New Zealand farmers towards nature, the *importance* placed on those values varied between organic, conventional and GE intending farmers. All farmer types agreed at least somewhat with the anthropocentric viewpoint. Organic and conventional farmers embraced the ecofeminist position to a similar degree, whereas GE intending farmers agreed less to its principles. The positions of deep ecology and econcentrism were valued differently by all three farmer groups. GE intending farmers were concluded to express sensitivity to their environment, but not emphatically, and they rated negative consequences of gene technology very unlikely as opposed to organic farmers. Their tactic appeared to be to wait until GE products emerge as a revolutionary technological fix to deal with environmental issues [68]. Such expectations are in stark contrast to the attitude of Norwegian farmers – representing mostly small scale farming – who disagreed very strongly with the statement that gene technology might solve future environmental problems in agriculture [67].

Overall, New Zealand organic farmers exhibited a higher level of sensitivity to nature than conventional or GE intending farmers [68]. Earlier studies have shown that there are differences in the attitudes and beliefs of organic and conventional farmers towards nature, conservation and the role of farmer as a caretaker of the land (e.g. [26, 84-86]). Such differences may stem from different ethical convictions about life in general which, in turn, determine technological choices in general and the use of GM crops in particular. In the US (WA), organic farmers were more likely than con-

ventional growers to evaluate environmental policies according to values that incorporate concerns beyond their individual economic interests. Interestingly, those organic growers who expressed willingness to try GM crops resembled conventional growers in several variables measuring attitudes towards consumer concerns of GM crops, environmental issues and importance of economic factors in farmers' professional lives. Overall, however, organic growers were typically more communal and consequential in their value orientations than conventional growers who tended to be on the libertarian side [70].

James [72], after conversations with Missouri farmers facing serious economic pressures, concluded that the ethical challenges of farmers seemed to be more behavioural than philosophical. In Scotland, Hall [16] collected over 700 statements regarding GM crops from farmers by using 13 open ended questions. Only one of the 48 statements selected to be representative of the initially collected 700 statements was of the form of an intrinsic value statement ("If only 'natural' genes are added to GM plants then it's ok but if it involves using genes from a different species then it is not ok"). This was the only explicit unnaturalness argument that was directly observable in the 17 reviewed studies. The scarcity of such statements is likely because the researchers did not explicitly ask farmers' about their naturalness/ unnaturalness perceptions regarding GM crops! Thus it appears at this stage that the most urgent issues that spring to farmers' minds when asked about GM crops do concern economic, practical agronomic and marketing issues instead of the intrinsic and extrinsic ethical values projected onto its consequences.

Role of Extrinsic Values in Adoption Decision-Making

Most papers acknowledged farmers' high level of knowledge and awareness of both potential health as well as environmental externalities of GM crops. This was true regardless of in which country the study was conducted, with only one pre-release exception. Chong [76] studied whether the moral aspects of risk figure in Indian farmers' perceptions of Bt eggplant, and whether economic benefits outweigh perceived risks in a pre-release situation. According to [76], none of the 100 interviewed farmers mentioned moral environmental or ecological concerns as an issue when considering the acceptability of the new crop. Chong [76] concluded that the risk models used in developed countries may not be appropriate for developing countries where economic benefits are more salient than moral concerns to producers. In the Indian context, eggplant farmers readily perceived health benefits from the use of Bt-eggplant owing to reductions in pesticide use. If *not* adopting the new technology means putting up with a high level of negative economic or health impacts, even quite risky technologies may be normatively acceptable to users [87]. Moral notions concerning a particular technology may not be universally important, and can be modulated by socioeconomic conditions [76].

In the developed countries, conventional farmers participating in the studies tended to express attitudes inferring economic values, particularly farm-level utility, as their first and foremost criteria for adopting GM crops. In Western Australia, canola growers were more likely in their intentions to plant GM canola if non-GM canola did not sell at a premium price or if yield advantage of the GM crop was anticipated. On the other hand, in addition to the economic and market access factors, the growers' decision to adopt GM canola depended also significantly on their attitudes toward risks: cross pollination with non-GM crops or weeds, and perceived need of more research into GM canola. Even in the scenario of ensuring yield advantage of GM canola and certainty of no price premium for non-GM canola, grower attitude regarding GM canola as being "bad for the environment" was still among the significant determinants of adoption intentions. In conclusion, growers were aware of the potential risks that might ensue to the greater community from GM canola, but still, the major decision factors were economic despite that concerns of ethical nature were commonly expressed [74]. McDougall *et al.* [66] arrived at similar conclusion regarding pulse growers in Western Australia. In New Zealand, farmers appeared to welcome any development that holds the prospect of improving their business, but their intentions were nevertheless dependant upon the realisation of relevant benefits and evidence of acceptable risk from the use of GM crops, in addition to market acceptability and on-farm profitability [69]. The New Zealand study was the only one employing the Theory of Planned Behavior in its strict sense to detect changes in farmers' attitudes toward GM crops, but only using attitudes, intentions and actual behaviour as components in the model. The outcomes of behavioural beliefs included improved better quality food, increased food production, enhanced economic growth, new risks to public health, adverse effects on future generations, damage to ecological systems, and personal risks. Of these, the likelihood of GM crops contributing to enhanced economic growth and increased food production were both perceived to be higher in the 2002 resurvey than in 2000, and the likelihood of ecological damage resulting from the use of GM crops was perceived to have decreased. In addition, fewer farmers agreed in 2002 that New Zealand should become GE free. As both the initial survey and the resurvey (with same respondents) were done in a pre-release situation, no meaningful changes in overall attitudes and intentions were detected. On the other hand, farmers in favour of organic methods appeared to simply reject gene technology in both surveys, considering it incompatible with organic farming [69].

In Canada, the majority of GM canola farmers were pleased with the benefits of the crop: ease of farm and weed management, higher yields, and saving time. Among the risks, those related to farmer's economy, particularly the loss of markets, and corporate power issues regarding intellectual property rights of GM seeds were perceived to be the most important. However, GM volunteer plants, gene spread, herbicide resistant weeds, problems with seed saving and damage to non-target species were also perceived as important risks. An important finding was that higher risk perception was associated with growing HT canola over multiple years [15]. This was in contrast to results obtained by Chimmiri *et al.* [79] in the US where the experience of growing GM corn or soybean increased farmers' perception of the ethicality of growing such crops. Interestingly, the experiences of benefits perceived to be related to growing HT GM canola did not transfer to Canadian farmers' positive attitudes regarding HT wheat [75]. Perceived risks of HT wheat were ranked higher than benefits and were associated with

previous experience with GM canola plus a strong belief in the importance of community and environment. Among the factors condensing farmers' risk perceptions of GM wheat, the factor named "contamination impact" accounted only for 4.1 % of variance compared to the 88.2 % of the market impact factor. Thus environmental impacts did figure in farmers risk perceptions but their role was small compared to market factors [75].

According to the study by Mauro *et al*. [75], Canadian farmers resented the secrecy of the test locations of GM wheat which could expose their non-GM wheat fields to pollen contamination. Such secrecy can be seen as disrespect to farmer autonomy and to their right to access of information in a situation where potential pollen flow from the test fields could contaminate farmers' fields. Canadian GM canola growers also experienced that they got too little information from the GM industry and government about pollen and seed contamination and problems with volunteers. This implies neglect of the farmers' right to all relevant information concerning the consequences of the new technology [75] and emphasizes the climate of uncertainty where farmers must decide about the adoption and use of GM crops. Mauro *et al*. [75] concluded that farmers' practice-based expertise is overlooked by decision-makers and regulators of GM crops in North America, i.e. their experience is not fed back to the regulatory and policy system. In the US, Guehlstorf's [77] study of Illinois farmers also concluded that the opinion of farmers has not been fully understood by policy planners, and that few farmers have ever had to discuss the social, environmental, and economic consequences of GM crops. Despite the fact that the utility or the benefit of the herbicide/insect tolerant GM crops outweighs the uncertain environmental risks, Illinois farmers continually questioned and evaluated their decision [77]. Whether such concerns expressed authentic environmental values Guehlstorf leaves open. The above situations of ignoring local experience-based knowledge are comparable to ignoring or denigrating of indigenous knowledge systems by change agents in the process of innovation diffusion [39] (p. 254-257). Farmer autonomy is also at stake in those instances when Canadian conventional farmers had to adopt GM canola only because their neighbours' fields inevitably contaminated their fields [15]. Spanish farmers of organic maize have experienced similar situations. Some had to abandon organic agriculture due to pollen flow from their neighbour's GM maize fields. In order to preserve good relationships, organic maize farmers did not always take legal action against the neighbour whose GM crop was the source of contamination [71]. Whether such dereliction is acceptable is also a moral question.

Farmers, as both producers and consumers of GM food, may have different attitudes of GM crops than consumers. Napier *et al*. [73] surveyed differences between urban and rural inhabitants (farmers) in their perceptions of risk of production and consumption of GM plants and animals. The extrinsic risks considered the most important – over and above the risk of loosing global markets for US farm products - were the creation of pesticide resistant weeds and insects, and destruction of beneficial insects. In all risk categories, rural respondents perceived the risks to be smaller compared to the perception of urban respondents. Farmers' greater experience and knowledge level of GMOs was concluded to contribute to the observed difference. Interestingly, in Norway the relative attitude of conventional farmers about the possibilities of gene technology solving future environmental problems in agriculture was *more* negative than that of conventional consumers in a pre-release situation [67]. The Norwegian farmers' attitude toward GMOs was measured only with one statement in a country of small-scale agriculture, so it is difficult to say whether the response reflects ethical orientations or market concerns. In Australia in the beginning of 2000s, farmers' attitudes concerning the acceptability of different types of GMOs were similar to those of consumers with only two exceptions (blowfly resistant sheep and HT wheat [66].

The study conducted by Hall [16] was interesting as she used also open-ended questions to prompt farmer attitudes and concerns of GM crops in Scotland. Several of the 48 farmer-originating statements dealt with issues that inferred about the extrinsic non-economic value orientations of the respondents in regard to environment and human health. Based on attitudinal differences, farmers were grouped as benefit believers, risk perceivers or fatalists. The benefit believers recognized that the GM technology needs to be proven safe and they demonstrated some concern of extrinsic safety issues, however farmers in this group were concluded to readily adopt GM crops if available. They were relatively unconcerned about potential cross-pollination, future risks, and impacts on wildlife, and they appeared to support the principle of substantial equivalence of GM food. All in all, the benefit believers apparently regard GM technology as any other agricultural innovation [16]. The perceptions of the benefit believers of Hall [16] appear comparable to those expressed by the GE intending farmers of [68] in New Zealand. In Australia, canola growers could be grouped in proponents and opponents of GM crops as well; their attitudes concerning extrinsic risks of GM crops also diverged along the pro- and anti-GMO demarcation line [74]. The risk perceivers, or reluctant adopters as named by Hall [16] were very concerned about the potential risks, public reaction, and consumer demand and they did not see that the benefits would outweigh risks. Farmers in this group were concluded to represent reluctant adopters of GM crops. The third group, the fatalists, expressed a "what will be will be" attitude towards the larger adoption of GM crops. Overall, the general conclusion made by Hall [16] of the Scottish farmers attitudes toward GM crop was that such crops will be no bad thing for Scotland, provided there is public acceptance and consumer demand, the right balance of benefits and risks, and technologically useful solutions. This is a very similar conclusion to that reported from New Zealand [69].

Swedish farmers' attitudes of GM crops produced two main groupings of farmers inferring different value positions toward the extrinsic consequences of insect resistant GM crops. Those in favour of GM crops predominantly displayed attitudes inferring economic values and tended to own larger farms. These farmers saw the potential of GM crops of reducing both insecticide costs, health risks to the grower as well as damage to other organisms compared to insecticide use [78]. These farmers' perceptions appear comparable to the GE intending farmers in New Zealand [68] and the benefit believers in Scotland [16]. Those with negative attitudes

towards GM crops in the Swedish study held the view that such crops provide no benefits and that they could be dangerous for humans and livestock to consume and also harmful to other organisms. The views of benefit and risk perceivers, although contradicting at first glance, imply in fact that both groups expressed concern for the environment and for the well-being of fellow humans or other species, but they seemed to approach the same goal from different value positions. For example, the concern for gene flow from GM crops to non-GM crops or weeds may arise from economic concerns associated with extra costs of segregating GM and non-GM crops [78], or it could arise from extrinsic values of farmers concerning the effect of GM crops on non-target species. Such value divergence/goal convergence has been shown also in the context of adopting other technologies [22, 85].

DISCUSSION

In essence, the reviewed papers represent implicit attempts to include the dimension of *ethical compatibility* as a perceived attribute of GM crops in studies of their adoption and diffusion. Only one of the reviewed papers [74] explicitly used innovation adoption/diffusion model as the theoretical background. Non-economic values do not figure prominently in the innovation diffusion research: the innovation-diffusion model (for a review, see [88]) or the economic constraint model [89]. One step towards understanding the importance of farmers' values as a factor contributing to innovation adoption is the adopter perception paradigm (see [90] for a review). The individual's perceptions of the attributes of the innovation affect the rate of adoption [39], p. 223. Perceptions are evaluated in reference to some internalized system of values or cognitive framework, resulting in a subjective rating of the significance of the innovation's attributes [90]. Among innovation attributes, compatibility is of special interest in the context of ethics of GM crops. Traditionally, compatibility is understood as "the degree to which an innovation is perceived as being consistent with the existing *values*, past experiences, and needs of potential adopters." [39, p. 240] Recently, Bunker *et al.* [91] applied the concept of *value compatibility* in a setting of an organization's cultural values when studying the adoption and implementation of information system. *Ethical compatibility* has traditionally not been used as an attribute of innovations. It is not explicitly mentioned as a dimension of the compatibility attribute by Rogers [61] or Tornatzky who reviewed the role and use of innovation attributes as part of the adopter-perception paradigm of innovation diffusion research [90], but as a concept ethical compatibility is emerging in the GMO debate [92, 93].

The study by Chimmiri *et al.* [79] used a plethora of statements many of which could serve also as perceived ethical compatibility attributes of GM crops. The dimensions of the ethical compatibility attribute of GM crops should include both intrinsic and extrinsic value connotations. If ethical compatibility were adopted in the repertoire of attributes describing subjectively perceived characteristic of agricultural (or any other) innovations, the whole definition of innovation would deserve a new dimension added to it. Such definition is proposed by Costello and Donnellan [94]: "An innovation is a human activity resulting in an artefact, idea, practice, organization, learning, or information system – perceived to be new by the unit of adoption – that is cognizant of the Lévinasian Other. Consequently, ethical issues must be considered that affect initiating, implementing, and using the innovation together with the associated employment of resources."

In the studies reviewed here, extrinsic values associated with GM crops as expressed by farmers were dealt with more extensively than intrinsic values, and overall, intrinsic and extrinsic concerns were usually not explicitly addressed as two different value domains. The distinctions between different types of intrinsic values (strong vs. weak or low vs. high) were not explicitly addressed in any study. Operational statements incorporating intrinsic values were included hardly at all in the questionnaire surveys to elicit value positions and attitudes of farmer respondents toward GM crops. Because the role of intrinsic values in questionnaires was so small, we did not try to distinguish between different types of them in our analysis. Nevertheless, the theoretical difficulties in separating between intrinsic and extrinsic were acknowledged partly through distinction between strong, weak, low and high values. Differentiating between intrinsic and extrinsic values and quantitative surveys cannot necessarily reveal the contents of moral judgements toward GMOs as explicitly as qualitative interviews. In fact, asking respondents to comment whether they regard GMOs as "ethical" or "morally acceptable" reveals very little on what the respondent may be thinking when ticking a Likert-scale box. The respondent may consider GMOs unnatural and contradicting the course of Nature, or he or she may actually have a form of understanding of usefulness or a broader concept of risk than the inquirer [95]. On the other hand, in studies on the general public acceptance of and attitudes toward GMOs, intrinsic value issues are a recurring phenomenon (e.g. [96]). Do we, unconsciously, regard conventional farmers as ethical weathervanes that turn and squeak at the mercy of the wind blowing from the direction of consumers? Hardly so black-and-white, although market concerns and consumer acceptance of GM products do play a crucial role in farmers' decisions concerning the adoption of GM crops.

Farmer typologies based on their attitudes toward GM crops were produced in several of the reviewed papers and there were indications that the grower typologies (based principally on extrinsic value orientations of farmers) were not totally dissimilar in different countries (UK (Scotland), Sweden, New Zealand, and Australia). One paper used as a starting point the attitude of farmers toward adoption of GM crops and then studied to what extent farmers in the three groups agreed about the three value positions presented to them [68]. This was an interesting approach and pushes one to think why farmer typologies based on *general* values have not been used more often to associate ethical values expressed about GM crops with general value typologies of farmers. Conventional farmers are not a homogeneous group, as shown also by studies that aimed at revealing differences among farmers towards farming practices [22, 97] and sustainability [23, 25]. Farmers' heterogeneity is acknowledged also in the traditional innovation diffusion studies focusing on GM crops. For example, the pricing and adoption of GM crops cannot be understood if producers are seen as being homogeneous [98]. Garforth and Rehman [99],

using TPB, typologized UK farmers based on their general farming objectives and values and arrived at five distinct groups: family orientation, business / entrepreneur, hedonic / hobbyist, life-styler, and independent / small farmer. According to the authors [99], these groups were not dissimilar to findings in a New Zealand study [100], thus the typology produced by Garforth and Rehman [99] may be generalizable to farmers in developed countries, although cultural, structural and economic influences cannot be ruled out as modifying the typology in different countries. General farmer values and farming objectives are likely to be reflected in farmers' management styles [see 85] and strategic decisions they make concerning what to grow and how to (or whether to) expand and diversify. The adoption of GM crops can be considered as either a strategic or a tactical decision at the farm level, depending on the goals and values of the farmer. Hypotheses could be produced concerning which farmer groups (as depicted in [99]) are likely to adopt and which are likely to reject GM crops on an ethical basis, and which groups are the most likely to adopt or reject these crops as a strategic choice and which ones as a tactical choice. The farmer typology [99] could be used also as a starting point to study to which extent intrinsic and extrinsic ethical values influence the innovation-decision process of GM crops and whether such values remain stable or change with the progress of diffusion of these crops.

Did the Illinois GM-farmers consider GM crops ethical and beneficial for both local and global consumers because the crops were producing on-farm benefits (cf. [79])? Or did they have this ethical conviction before adopting GM crops, in which case their ethical perceptions contributed to a positive adoption decision? The term "reluctant adopter" [16] implies that one group of farmers incorporates a potential for trading –off or changing their values and attitudes toward GM crops once enough information becomes available about the innovation and innovators and early adopters take the technology in use. Some may end up adopting GM crops against their will and values also for very "practical" reasons, i.e. due to unavoidable contamination of fields with seed or pollen drift from neighbours' GM fields [15, 71]. Some may not be able to resist the irresistible economic benefits despite their initial negative attitudes toward biotechnology! [72] Speaking with a mouth of a conventional (industrial?) farmer, Erickson [101, p.90] proclaims: "Growers will use a technology when it makes sense from the business standpoint."

TPB would offer possibilities for studying the change in the importance of intrinsic and extrinsic values (and low and high as well as strong and weak values) in the adoption decision at different stages of the innovation-adoption process, starting from the pre-release stage. This may be possible provided the incorporation of the intrinsic and extrinsic values in the independent antecedent components describing personal values and norms is carefully considered and operational statements of outcome beliefs equally carefully associated with different types of outcomes [cf. [59]). In order to capture both the pre-release and post-release situation answers to the above questions should be sought in countries where GM crops are not cultivated yet but where their adoption and diffusion is anticipated.

The feel that seems to characterize the experience of farmers who are using GM crops and who, at the same time, are aware of the potential food safety and environmental risks - or the debate concerning them - reminds the feel of walking on thin ice. Guehlstorf [77] describes how GM-farmers constantly evaluate and question their decision. McDougall *et al.* [66] state how farmers' attitudes toward GM crops were most positive where a direct benefit to farm production was indicated, but nonetheless significant concerns over socio-economic, environmental and human health issues were present. Even farmers with high levels of acceptance toward GMOs in agriculture may still be moderately to extremely concerned about environmental and food safety issues. What does it mean – to be concerned but intend to adopt *nonetheless*? And particularly: to be concerned but to *use* the technology *nonetheless*? In the US and Canada where GM crops have been in use for over a decade, many farmers have a long-time experience on the feeling of "walking on thin ice", accumulating experience of the use of GM crops – and ending up realizing that this experience of theirs is not fed back to a sufficient degree to the policy and regulation system. Surely the farmers' possibilities to achieve peace of mind depend also on the social and ethical climate (societal and moral norms) where they practice their profession. The farmers in North America probably sleep better than those in Europe after making the adoption decision owing to the difference in the public attitudes towards GM crops between these continents. [102-104]. The eggplant farmer in India may sleep better after than before adoption, because he genuinely will come to believe he made a good decision that benefits not only himself but also consumers who buy his eggplants [76].

So what about principles of beneficence, non-maleficence, fairness and justice, and choice and self-determination seen from the farmer perspective? This review revealed that in countries where GM crops have been grown for several years, adoption of GM crops is not always a voluntary decision anymore due to inevitable contamination from neighbour's fields. Furthermore, the autonomy and farmers' right to get appropriate information of GM crops (also after GM crops have been taken in use) and to become heard in the policy-making process in issues concerning GM crops' practical use are not being fulfilled to the extent farmers would desire and regard as fair. Ahteensuu and Siipi [105], by using the Finnish and European example of the procedural shortfalls of public engagement in GMO consultations, take the issue of desirability of two-way information flow to a more general level and argue for all citizens' rights to have a genuine possibility to influence societal decision-making of GMO policies. The current system of public consultation does not offer possibilities for this to a sufficient degree. On the other hand, experiential evidence is accumulating that segregation of some GM and non-GM crops is not possible despite technical coexistence measures and liability schemes. This results, in practice, in promotion of biotechnological agriculture over an organic or conventional non-GM agriculture [71]. The behaviour of farmers has also been proven quite unexpected in some instances where social values (respect for good neighbour relations) override legal rights to sue neighbouring farmers for GM contamination. Such behaviour can lead to new, unanticipated ethical and even legal problems.

CONCLUSIONS

The answer to the first question presented in the Introduction (To what extent are conventional farmers guided by intrinsic and extrinsic ethical values in deciding whether to adopt GM crops?) appears to be the following: Intrinsic values – well, we do not know exactly, as the farmers were seldom asked explicitly about their intrinsic values attributed to GM crops. Even in the few qualitative studies where farmers ethical perceptions were probed into, they were seldom reported to mention intrinsic values explicitly as determinants of their decision-making or attitude toward GM crops. When farmers' general value positions toward nature were elicited and associated with their intentions concerning adoption of GM crops, the GM intending farmers' value position was leaning more toward the anthropocentric conception of nature, suggesting they were judging the pros and cons of GM crops on the basis of extrinsic values. Whereas other conventional farmers not so accepting toward GM crops appeared to emphasize more also intrinsic values when judging pros and cons of GM crops. They placed stronger emphasis of ecofeminist, ecocentric and deep ecology conceptions of nature. In many instances, economic values tend to override ethical concerns when farmers make decisions on the use of GM crops, particularly if they see farm- or crop-level financial benefit of them, but the ethical concerns remain as a constant companion of farmers who have adopted GM crops, even after years of growing them. At the moment it is not known exactly to which extent the values and ethical attitudes possessed by individual farmers toward GM crops are stable or whether they change with the progress of the diffusion process and accumulation of information on these crops. There is some evidence that perceiving GM crops as ethical grows stronger with accumulating experience on their use, but opposite evidence is also available and generalizations may not be possible over all GM traits, crop species, and countries. On the other hand, prolonged use of GM crops in some countries has revealed certain agronomic and ecological risk issues as well as issues of autonomy and justice that were not necessarily anticipated. Thus, as an answer to the question number 2 posed in the beginning: there *are* situations of using GM crops where the principles of individual farmer autonomy as well as that of fairness and justice (see [18, 19]) are either threatened or violated. Both GM farmers, conventional non-GM farmers and organic farmers expect that their experience be taken into account and their voice heard when further policy and regulation decisions are made of GM crops.

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