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Farmer Behaviour as Reasoned Action: A Critical Review of Research with the Theory of Planned Behaviour

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Abstract

In many countries farmers face pressure to adopt practices to promote sustainability and resilience while ensuring efficient business management to produce food and other agricultural products at reasonable cost. Given a policy context in which voluntary action is preferred over government regulation, understanding farmers' motivation to embrace recommended practices has become a major subject for research. Increasingly, this endeavour is guided by the theory of planned behaviour, a reasoned action approach (Fishbein and Ajzen, 2010). We provide a brief overview of the theory of planned behaviour and an elaboration of good practices in the assessment of the theory's constructs. We systematically review 124 applications of the theory to farmer behaviour on a number of specific review criteria. Based on observations of improper use, we consider theoretical and methodological issues and provide recommendations for research design and data analysis.

Keywords: *Decision making*; *farmer behaviour*; *reasoned action approach*; *reflective and formative measurement*; *review*; *structural equation and MIMIC models*; *theory of planned behaviour*.

JEL classifications: *C51, C52, D83, H32, Q12*.

1. Introduction

In many countries farmers face pressure to adopt practices that promote sustainability and resilience while ensuring efficient business management to produce food and other agricultural products at reasonable cost. In the European Union, policy-makers have set nine objectives for the common agricultural policy (CAP) after 2020 to 'ensure

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access to high-quality food and strong support for the unique European farming model' (European Commission, 2020). Over the years, the EU has progressively integrated sustainability principles into both pillars of the CAP. Both the newly announced 'eco-schemes' for Pillar 1 and the 'agri-environment-climate measures' in Pillar 2 depend on voluntary participation by farmers (European Commission, 2019). These schemes and measures incentivise farmers to voluntarily going beyond the mandatory requirements to maintain and enhance eco-friendly farming practices. The reliance on voluntary participation extends to many areas of agricultural policy, including food safety, biosecurity, and disease control (Schulz and Tonsor, 2010; Segerson, 2013; Sok and Fischer, 2020).

Given a policy context in which voluntary action is preferred over government regulation, deepening the understanding of human decision making and improving the prediction of farmer behaviour has become a major focus of research (Dessart *et al.,* 2019; Thomas *et al.,* 2019; Streletskaya *et al.,* 2020).

The theory of planned behaviour (TPB; Ajzen, 1991, 2012) – a reasoned action approach (Fishbein and Ajzen, 2010) – is a well-known and frequently applied framework for explaining and predicting human behaviour. It focuses on the controlled aspects of decision-making and on behaviours that are goal-directed and steered by conscious self-regulatory processes. Contrary to the assumption of a rational decision maker in the expected utility model, the workhorse for both theoretical and empirical research in agricultural economics (Just *et al.,* 2010), the TPB merely postulates that decisions and actions are based on some measure of reasoning, that is, that people take account of various considerations as they contemplate their options.

The theory of planned behaviour not only provides an accessible and empirically supported conceptual framework, it is also accompanied by well-established guidelines for measuring the social-psychological constructs that comprise the theory. These guidelines on how to correctly design a survey instrument are widely available (e.g., Fishbein and Ajzen, 2010, *Appendix for sample measures of the TPB constructs*; Ajzen, 2020). This makes it relatively straightforward for researchers with no background in social psychology to conduct their research. In terms of consumer behaviour, some recent applications include the consumption of organic food (see Scalco *et al.,* 2020 for a review), fruits (Canova *et al.,* 2020), and novel foods, such as insect-based products (Menozzi *et al.,* 2017) . On the producer (farmer) side, many applications can be found as well, most prominently in the area of conservation and biosecurity and disease control (Sok *et al.,* 2015; Borges *et al.,* 2016; Daxini *et al.,* 2019; Vaz *et al.,* 2020). The TPB has also been used in discrete choice experiments to provide explanations for preference heterogeneity (Nocella *et al.,* 2012; Sok *et al.,* 2018a) and in agent-based modelling of farmer behaviour. Examples with empirical data can be found in Kaufmann *et al*. (2009) and Sok and Fischer (2020).

Unfortunately, many studies that have relied on the TPB to explain and predict farmers' behaviour have failed to conceptualise and assess the theoretical constructs in line with established principles and guidelines. This critique is not new. Burton (2004), for example, wrote that investigators sometimes mention use of the TPB, not because they actually relied on it to design and guide their research, but merely to justify their approach, giving their studies an apparent legitimacy that they might not deserve.

While the TPB is often put forward in review articles as a suitable conceptual framework for the study of farmer behaviour across different decision domains (e.g., Burton, 2004; Edwards-Jones, 2006; Fielding and Hornsey, 2016; Gilbert and

Rushton, 2018; Dessart *et al.,* 2019), no systematic literature review has been carried out focusing on *how* the TPB has actually been applied to farmer behaviour. To fill this gap in the literature, our objective is to provide an overview of *how* the TPB has been applied, evaluating eligible applications on a number of specific criteria, most of which have been described by Fishbein and Ajzen (2010). Among other things, these authors are concerned with adherence to the principle of compatibility, use of a pilot study, the role of background factors in the data analysis, and testing of the sufficiency assumption. In addition, based on the distinction between reflective and formative measurement models (Blalock, 1964; Diamantopoulos *et al.,* 2008) , we evaluate how the relationships among the theory constructs were analysed.

This article proceeds as follows. We first present in section 2 a brief overview of the TPB, followed in section 3 by an elaboration of a number of theoretical and methodological practices that researchers are advised to follow as they assess the TPB constructs in relation to farmer behaviour. This section also presents the specific review criteria employed. Section 4 describes the materials and procedures used for the systematic literature review using the PRISMA diagram (Moher *et al.,* 2009). We review 124 scientific articles that claim to have used the TPB for the prediction of farmer behaviour and evaluate them in terms of our criteria. Our findings are presented in section 5 in which we first provide a classification of applications by farm management aspect and type as well as a classification of the articles based on the theory elements selected for measurement and analysis. This is followed by an analysis of the reviewed studies in terms of the criteria elaborated in section 3. A discussion and our recommendations for future research are presented in section 6.

2. A Brief Description of the Theory of Planned Behaviour

Fishbein and Ajzen (1975; see also Ajzen and Fishbein, 1980) developed the theory of reasoned action (TRA) in response to the failure of broad social attitudes to predict behaviour (Wicker, 1969; Fishbein and Ajzen, 1974). They suggested that, instead of broad attitudes, the intention to perform a given behaviour is the most immediate antecedent and best predictor of actual behavioural performance. In the TRA, attitude is conceptualised as the evaluation of the behaviour's desirability. Attitude toward the behaviour is but one of two constructs that were assumed to determine behavioural intentions. The second construct was termed subjective norm and it refers to people's perceptions of what important others think they should do, whether others would approve or disapprove of their behaviour.

The TRA assumes that most behaviours of interest to social and behavioural scientists are under complete volitional (self) control and, therefore, once an intention is formed, it is expected to initiate the behaviour under appropriate circumstances. However, it soon became clear that the assumption of perfect volitional control placed severe limitation on the theory's ability to deal with behaviours that are difficult to execute, which may prevent people from acting on their intentions. In fact, many behaviours require certain skills, knowledge or cooperation by other people; and may demand the ability to overcome such barriers as lack of money, time or other resources. For this reason, Ajzen (1985) added the construct of control, calling his revised model the theory of planned behaviour (TPB). In the TPB, actual control over a behaviour is said to moderate the effect of intention on behaviour such that intentions are likely to lead to performance of the behaviour to the extent that actual control is high. Moreover, relying on Bandura's (1977) construct of self-efficacy,

Ajzen postulated that the extent to which people believe that they have control over behavioural performance can influence their intentions and thus have an indirect effect on behaviour. Perceived behavioural control, defined as people's perceptions of their ability to perform a given behaviour, has therefore been added as a third determinant of intention.[1] In most empirical investigations, however, it is difficult or impossible to determine how much control a person actually has over performance of a given behaviour, so perceived behavioural control is typically used as a proxy for actual control. To the extent that this is an accurate reflection of actual behavioural control, it can, together with intention, be used to predict and explain behaviour.

To summarise, equations (1) and (2) present the TPB in symbolic form, where B is a given behaviour, I is the intention to perform the behaviour, AC is actual control, PBC represents perceived behavioural control, A is the attitude toward the behaviour, SN represents subjective norm. Both equations are usually estimated in an additive manner without the recently postulated moderation effects of PBC on A and SN.

$$B = f(I, AC^{-}PBC) \tag{1}$$

$$I = f(A, SN, PBC) \tag{2}$$

Based on an expectancy-value model of attitude developed earlier by Fishbein (1963), Fishbein and Ajzen (1975) proposed that attitude toward a behaviour is a function of readily accessible beliefs about its likely consequences or outcomes, termed behavioural beliefs, weighted by the subjective values or evaluations of these outcomes. Specifically, in line with subjective expected utility theory (Feather, 1959, 1982), the subjective probability or strength of the behavioural belief (b) that a behaviour will produce a certain outcome or experience is multiplied by the person's evaluation (e) of the outcome or experience, and the products are summed across all accessible behavioural beliefs ($i = 1, \ldots, s$). This expectancy-value model of attitude toward a behaviour (A) is shown in equation (3).

$$A \propto \sum_{i=1}^{s} b_i e_i \tag{3}$$

Drawing an analogy to the attitude model, Fishbein and Ajzen (1975) assumed that subjective norm is determined by the total set of accessible normative beliefs concerning the expectations of important social referents. The strength of a normative belief for a given referent is weighted by the person's motivation to comply with the referent in question, and the products are aggregated across all accessible normative beliefs ($j = 1,\ldots,t$). Equation (4) shows a representation of subjective norm, where SN represents subjective norm, n is the strength of an accessible normative belief concerning the expectation of an important social referent, and m is the motivation to comply with the referent in question.

[1]In the original formulation of the TPB (Ajzen, 1985), perceived behavioural control was assumed to moderate the effects of attitude and subjective norm on intention. In recent years, investigators have provided evidence for the originally postulated interaction effects, showing that perceived behavioural control can in fact moderate the relation between attitude and intention and between subjective norm and intention (e.g. Castanier *et al.,* 2013; Hukkelberg, *et al.,* 2014; Yzer and van den Putte, 2014).

$$SN \propto \sum_{j=1}^{t} n_j m_j \tag{4}$$

Again drawing an analogy to the expectancy–value model of attitude, it is assumed that perceived behavioural control is determined by the total set of accessible control beliefs, that is, beliefs about the presence of factors that may facilitate or impede performance of the behaviour. Specifically, the strength of each control belief (c) is multiplied by the perceived power (p) of the control factor, and the products are aggregated across all accessible control beliefs ($k = 1, \ldots, v$). Equation (5) shows a representation of this model, where PBC represents perceived behavioural control.

$$PBC \propto \sum_{k=1}^{v} c_k p_k \tag{5}$$

In their most recent book, Fishbein and Ajzen (2010) further develop the conceptualisation of the TPB's predictors of intentions. In contrast to the unitary definition of attitude toward a behaviour as a person's favourable or unfavourable evaluation of the behaviour, empirical research has identified two clearly distinguishable subdimensions: an *instrumental* factor having to do with the extent to which performance of a behaviour is perceived to produce desirable or undesirable outcomes and an *experiential* factor, which reflects the degree to which performance of the behaviour is perceived to be pleasant or unpleasant. Similarly, perceived behavioural control is found to contain two sub-dimensions, one labelled *capacity*, people's perception that they are or are not capable of performing a given behaviour, and the other termed *autonomy*, referring to the degree to which people believe that performance of the behaviour is or is not completely up to them. Finally, relying on the work by Cialdini and his associates (e.g., Cialdini *et al.,* 1990; Cialdini, 2012), Fishbein and Ajzen (2010) drew a distinction between *injunctive* and *descriptive* aspects of subjective norm. The former refers to people's perception of what others would like them to do or what is expected of them whereas the latter are perceptions of what important others themselves do. Descriptive norms form a bridge to social networks and their effects on perceptions of what important others do (Tatarko and Schmidt, 2016). Each of these perceptions can influence perceived pressure to engage (or not engage) in the behaviour, that is, subjective norm.

3. Good Practices in the Assessment of TPB Constructs

3.1. The principle of compatibility and use of a pilot study

In research with the TPB it is important to clearly define the behaviour under study in terms of the target at which it is directed, the action performed, the context in which it occurs and the relevant time period. This is often abbreviated as the TACT elements of the behaviour. The principle of compatibility requires that all constructs in the TPB be defined and assessed in terms of the same TACT elements (construct compatibility). Secondly, when feasible, the measurement scales employed (quantity vs. likelihood ratings) should be compatible across constructs, known as scale compatibility. If the principles of construct and scale compatibility are not observed, weaker and less robust correlations among constructs are expected.

If the research is intended to explore the most influential beliefs behind attitude, subjective norm and perceived behavioural control, it is necessary to conduct a pilot study in which readily accessible behavioural outcomes, normative referents and control factors are elicited. A content analysis is then performed to select the most commonly mentioned responses. These are used to construct behavioural, normative, and control belief items that are included in the final survey instrument. In addition to eliciting readily accessible beliefs, the pilot study is used to test whether the items that were formulated to obtain reflective ('direct') measures of attitude, subjective norm, perceived behavioural control and intention have acceptable psychometric properties.

In our review, we coded for use of a pilot study to construct belief items and for adherence to the principle of compatibility in the formulation of the questionnaire items.

3.2. Analysing the relative impact of TPB constructs on intention

The most fundamental concerns of data analysis in research with the TPB are the model's predictive validity and the relative impact of attitude, subjective norm and perceived behavioural control on intention. Multiple regression and structural equation modelling (SEM) are the most frequent methods employed. From a measurement perspective, intention and its immediate determinants are unobservable constructs (Bollen and Hoyle, 2012). A construct is a latent variable that can be defined in conceptual terms but cannot be directly measured or measured without error. The TPB constructs can be assessed by means of reflective indicators (often called 'direct measures'), such as bipolar semantic differential scales (*see* Fishbein and Ajzen, 2010, *Appendix for sample measures of the TPB constructs*). The observed indicators are considered to be functions of the latent variables, such that changes in the latent variable are *reflected* in changes in observed indicators (e.g. Jarvis *et al.,* 2003; Coltman *et al.,* 2008). The psychometric properties of these kinds of direct measures are best estimated by means of confirmatory factor analysis (CFA, see Hair *et al.,* 2010 and Brown, 2015 for an overview). It is expected that items designed to assess the same construct correlate well with each other and hence load highly on a single factor representing the underlying construct (convergent validity, see Bollen and Lennox, 1991) and that items designed to assess one construct do not load strongly on factors representing other constructs (discriminant validity). In SEM, once the measurement model – based on the CFA results – is evaluated and confirmed, the relations among the constructs, that is, the structural model specified by the theory, is tested (for an overview, see Kline, 2016).

The criteria we considered were the method of analysis employed over time (2006–2020) to assess the model's predictive validity and the relative impact of the TPB constructs on intentions. Also, because SEM is known as a large sample technique,[2] we coded for sample sizes across the different analysis methods used.

[2]The minimum sample size for covariance-based SEM is regarded usually as 200, while a rule of thumb is a sample size of 15 times the number of observed variables or 10 times the number of free parameters in case of strongly kurtotic data (Golob, 2003; Kline, 2016). However, additional determinants like amount of random measurement error influence these recommendations.

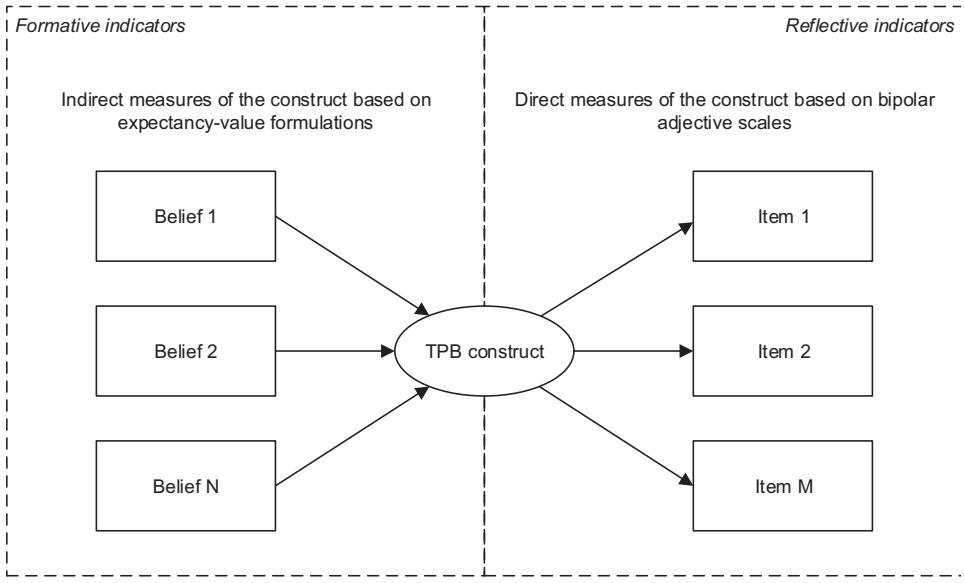

Figure 1. Path diagram of the multiple indicators multiple causes (MIMIC) model structure.

3.3. Identifying influential behavioural, normative and control beliefs

Another focus in a subset of TPB studies is identification of the most influential beliefs that drive the behaviour. When it comes to the measurement of beliefs, the observed indicators (often called 'indirect measures') are seen as causes of the latent variables, whereby changes in observed indicators cause changes in the latent variable (e.g. Diamantopoulos and Winklhofer, 2001; Jarvis *et al.,* 2003; Coltman *et al.,* 2008). Consistent with the expectancy-value model of attitude, items assessing behavioural beliefs (belief strength × outcome evaluation) are considered formative indicators, each belief contributing to the formation of attitude. The same logic applies to the effects of normative beliefs on subjective norm and the effect of control beliefs on perceived behavioural control. Unlike items reflective of the constructs, the formative items may be inconsistent with each other as when one behavioural belief associates performance of the behaviour with a positive outcome while another associates it with a negative outcome. Consequently, formative items are not required to show high internal consistency (Bollen and Lennox, 1991). Furthermore, they are not interchangeable like reflective items (Brown, 2015). In the SEM family of models, a multiple indicators and multiple causes (MIMIC) model can include both reflective and formative indicators (Jöreskog and Goldberger, 1975; Coltman *et al.,* 2008; Diamantopoulos *et al.,* 2008). A path diagram of a MIMIC model is illustrated in Figure 1.

The criteria we looked into were the choice of the analysis method over time (2000–2020) to identify the most influential beliefs and the sample sizes across the different analysis methods used.

3.4. The sufficiency assumption and additional predictors of intention

According to the TPB, intentions can be predicted from attitude, subjective norm and perceived behavioural control. No other predictors should have a direct impact on intentions. This is known as the sufficiency assumption. However, the TPB is in principle open to the addition of other predictors if they can be shown to influence intentions in a consistent and substantial way across a variety of behaviours (Fishbein and Ajzen, 2010). Indeed, investigators have proposed various additions to the model, including anticipated regret or, more generally, anticipated affect, habit strength and self-identity.

The criteria we looked into were how additional predictors were added to the parsimonious TPB model, and whether researchers explicitly reported the unique variance in intention explained.

3.5. Background factors

As discussed, behavioural, normative and control beliefs provide the basis for attitude, subjective norm and perceived behavioural control, respectively. These beliefs are assumed to be formed in daily encounters by way of direct observation; by accepting information from outside sources, such as the news media or the internet; and derived in a process of inference from other beliefs formed in the past (Fishbein and Ajzen, 1975, 2010). The TPB does not specify the origin of beliefs about any particular behaviour, but it does suggest that various background factors may play a role. Potentially influential background factors are properties of the individual or the social group, such as gender, age, education, personality traits, values, risk-taking propensity, intelligence, sensation seeking, religion, culture, and so forth (Fishbein and Ajzen, 2010). To the extent that a background factor is found to influence behaviour, it is assumed to do so indirectly by its effects on behavioural, normative and/or control beliefs. In addition to their potential importance for understanding differences in beliefs, background factors may also be found to moderate the relations among the theory's constructs.

We examined how background factors were added to the parsimonious TPB model to analyse these roles in the conceptual framework.

4. Methods and Procedures

As mentioned earlier, the TPB has been developed on the basis of the theory of reasoned action by adding the constructs of actual and perceived behavioural control to the model. Our review of research on farmer behaviour included studies that relied on either one of these two models. In the following paragraphs, we describe the methods and procedures we employed in our review of this research.

We ran a search query through the abstract and citation databases Scopus® and Web of Science to select articles for review.[3] The search included all versions of the

[3]The search query was defined as:(ABS("TRA" OR "TPB" OR "RAA" OR "Theory of Reasoned Action" OR "Theory of Planned Behavior" OR "Theory of Planned Behaviour" OR "Reasoned Action Approach" OR "Integrative model" OR "Integrative model of behavioral prediction" OR "Integrative model of behavioural prediction" OR "Fishbein" OR "Ajzen"))*AND* (ABS("intention" OR "attitude" OR "norm" OR "control"))*AND* (ABS("agriculture" OR "agricultural" OR "farm" OR "farmer" OR "farming"))*ANDNOT* (ABS("Consumer" OR "Consumers" OR "Citizen" OR "Citizens" OR "Student" OR "Students"))*AND* PUBYEAR> 2000

two models, whether mentioned in British or American English spelling, in combination with their main constructs, and in combination with nouns indicating the behavioural domain. We selected articles that were published from 2000 onwards. The closing time of the search query was May 2020.

Figure 2 summarises our selection procedure. Our search of the two data bases resulted in 253 articles (listed in the online appendix, and detailed in the separate online data file). These were screened in two steps based on a number of inclusion criteria. In the first step, the articles were screened for the behaviour studied, and only those that tested farmer behaviour were retained. This resulted in a total of 175 articles, of which in the second step 51 were removed because they did not meet one or more of the following eligibility criteria: written in a non-English language (5 articles), that did not have a peer-reviewed (DOI) publication status (24 articles), took a qualitative analytical approach (20 articles), or were not accessible (3 articles).[4] These procedures resulted in 124 articles that were judged eligible for inclusion in the synthesis. The references for these papers are provided in our online appendix.

5. Results

5.1. Applications of farmer behaviour

Figure 3 gives a classification of the applications by farm management aspect and type. The classifications are not mutually exclusive; sometimes an article fits in more than one class. This was especially true of articles that addressed a farm management aspect related to conservation and sustainability.

Of the 124 articles, 40% assessed farmer behaviour in a crop management context. A wide variety of crop management aspects were studied, including disease control, switching to alternative farming systems (e.g. organic), and participating in agri-environmental schemes. Articles addressing farmer behaviour in a livestock management context (32%) mainly focused on grassland management (land and landscape class), biosecurity and disease control, and animal welfare. In articles that surveyed farmers from multiple (or mixed) farm types (23%), business development issues such as diversification or specialisation, and succession, were studied most. A few articles (4%) reported studies of farmer behaviour in a forestry context and recently the first paper in the context of fish management has appeared.

5.2. Heterogeneity in design of TPB studies

The TPB contains a number of constructs, not all of which are always included in the survey instrument. Table 1 shows the constructs included in the studies reviewed. Specifically, we examined the presence or absence of the following assessments: intention and/or behaviour; reflective and/or formative indicators of attitude, subjective norm, and perceived behavioural control; additional direct predictors of intention; and background factors. It can be seen that in 40 articles (32%), behaviour was measured in some way, such as using farm production or performance parameters, risk management strategies, or past behaviour. Intention was measured in 100 articles

[4]The criteria 'Empirically testing farmer behaviour?', 'Language: English', 'Publication status: peer-reviewed article', 'Type of analysis: quantitative' were all scored using the title and abstract.

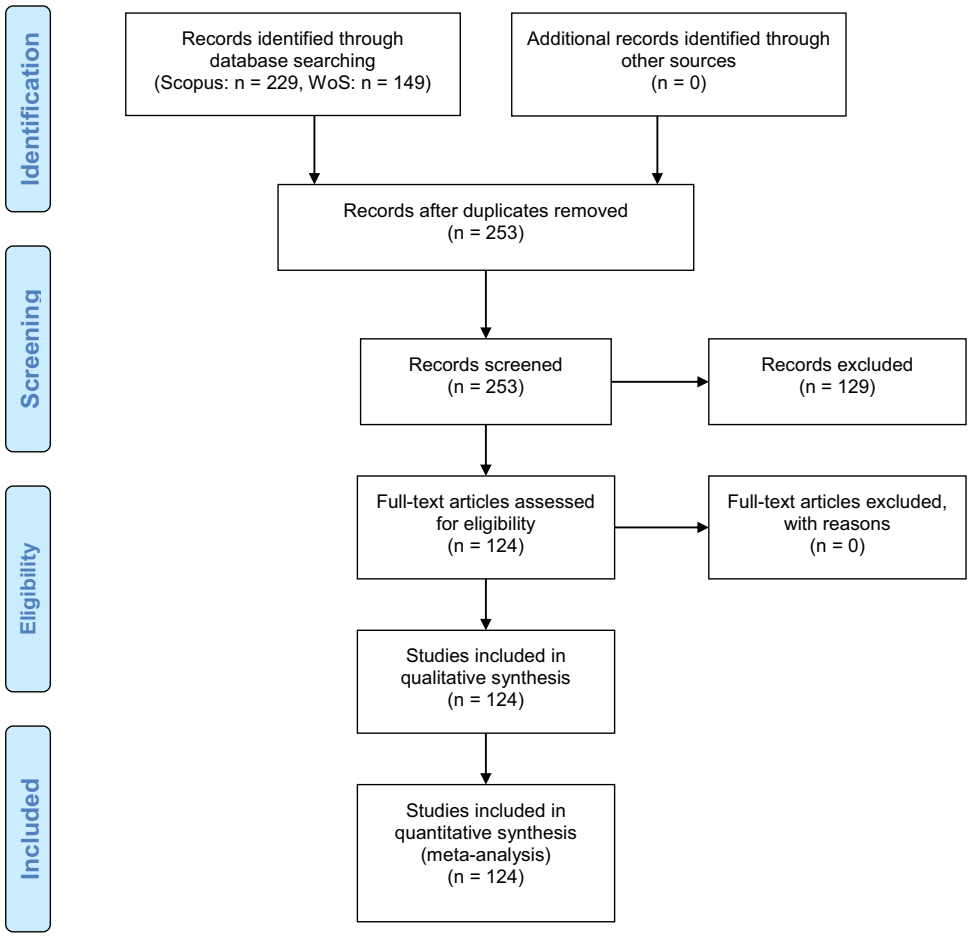

Figure 2. PRISMA diagram. The preferred reporting items for systematic reviews and meta-analysis (PRISMA) flow diagram identifies the total number of articles initially surveyed, the number of articles included and excluded for this systematic review (Moher *et al.,* 2009).

(81%), reflective (direct) measures of attitude, subjective norm and perceived behavioural control in 87 articles (70%), formative (indirect) measures in 56 articles (46%), additional predictors in 52 articles (42%), and background factors in 51 articles (42%). The measurement of background factors was of interest for our purposes only when the factors were used as part of the tested model; not only for examining sample representativeness.

Inspection of Table 1 also shows that the studies varied a great deal in their assessment of the theory's constructs. The most frequently included constructs were intention, direct measures of attitude, subjective norm, and perceived behavioural control, and additional predictors of intention (with or without background factors). Statistical analyses focused on the relative impact of attitude, subjective norm and perceived behavioural control on intention and on challenging the sufficiency assumption by extending the TPB with additional predictors. When indirect (formative) measures were included, investigators examined the list of elicited behavioural, normative, and

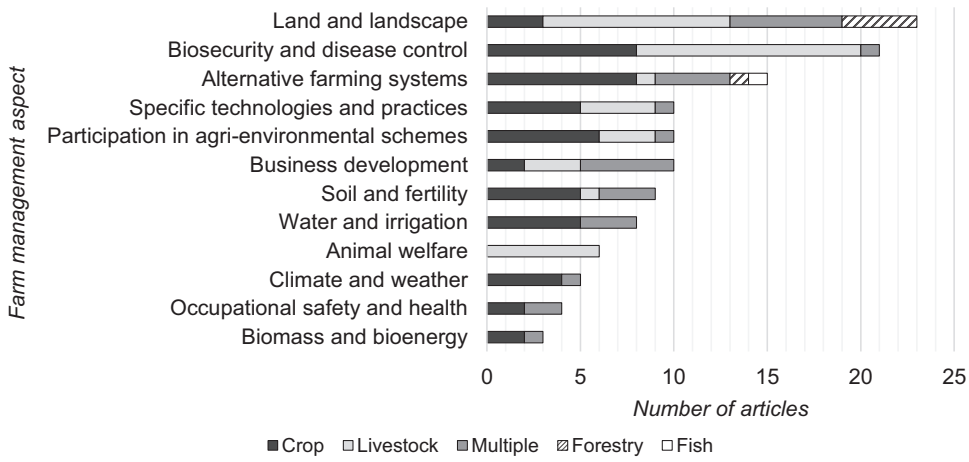

Figure 3. Classification of reasoned action theory applications by farm management aspect and type.

control beliefs to identify the most influential beliefs in terms of explaining and predicting behaviour. Note here that some authors published more than one article based on the same dataset, using different parts of the data or employing different analytical strategies. Finally, nine articles (7%) failed to include any measures (direct or belief-based) of attitude, subjective norm and perceived behavioural control. Testing the TPB's central hypotheses was therefore not possible.

5.3. The principle of compatibility and use of a pilot study

As discussed in section 2, measures of the TPB constructs are required to observe the principle of compatibility such that each construct involves the same target, action, context, and time elements as the behaviour under study (construct compatibility). In addition, correlations among the constructs can also be affected by compatibility in the measurement scales employed (scale compatibility). We selected the articles that reported assessing at least two of the theory's constructs and evaluated them in light of their construct and scale compatibility. In this part of the review, we also ascertained whether the investigators conducted a pilot study (prior to the main study) to elicit behavioural, normative, and control beliefs and/or to test the psychometric properties of the direct (reflective) measures of the TPB constructs.

The data presented in Table 2 show that in only one third (33) of the 100 applicable studies the principle of compatibility was fully met, and only about one half (51) conducted a pilot study. Remarkably, of the 71 articles that used a form of regression analysis to predict intention from attitude, subjective norm and perceived behavioural control, 36 did not report the amount of explained variance in intention. Of the 35 articles that did report the amount of variance explained, 14 met both principles of compatibility while 2 used measures that adhered only to the scale compatibility principle; 19 studies included measures that lacked both construct and scale compatibility.

Table 1
Classification of the 124 reviewed articles based on the theory elements selected for measurement and analysis

Background factors	Additional direct predictors of intention	Formative indicators of TPB constructs	Reflective indicators of TPB constructs	Behaviour Intention	No		Yes		
					No	Yes	No	Yes	
No	No	No	No		2				*2*
			Yes			8	2	5	*15*
		Yes	No		2	4	1	2	*9*
			Yes		2	9	2	2	*15*
	Yes	No	No						
			Yes			14	1	7	*22*
		Yes	No			6		1	*7*
			Yes			3			*3*
Yes	No	No	No		1	1	1		*3*
			Yes			6	1	2	*9*
		Yes	No		1	4	3	3	*11*
			Yes			6		2	*8*
	Yes	No	No		2		1	1	*4*
			Yes		1	10		1	*12*
		Yes	No			1			*1*
			Yes			1	1	1	*3*
				Subtotal	*11*	*73*	*13*	*27*	*124*

Table 2
Classification of selected articles (n = 100) based on their conformation to the principle of compatibility and use of a pilot study

Principle of compatibility					
Items formulated according to TACT	Measurement scales are the same	Use of a pilot study	No	Yes	
No	No		31	18	*49*
	Yes		4	0	*4*
Yes	No		1	2	*3*
	Yes		10	23	*33*
Not clear	Not clear		3	8	*11*
		Subtotal	*49*	*51*	*100*

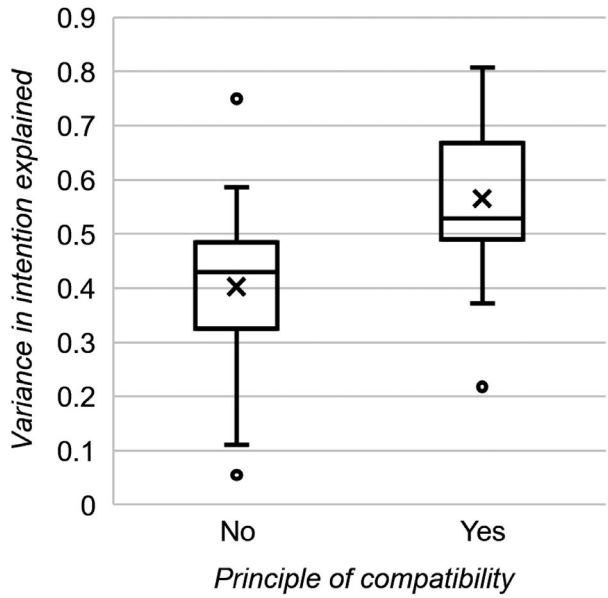

Figure 4. Boxplot of the distributions of the variance in intention explained for two groups that did or did not conform to the principle of compatibility (crosses represent the means).

The boxplots in Figure 4 shows the effect of compatibility in the 35 studies that reported the amount of explained variance in intentions. As can be seen, the 16 studies that met the criteria of compatibility accounted, on average, for 57% of the variance (SD = 0.16) compared to an average 40% (SD = 0.17) of explained variance in the 19 studies whose measures lacked compatibility. The difference in explained variance is statistically significant; $t(32) = 2.9$, $p = .003$. Because the normality assumption is likely violated, we ran a one-tailed Mann-Whitney U test, which resulted in the same conclusion.

5.4. Analysing the relative impact of TPB constructs on intention

We selected all articles ($N = 100$) that reported measuring intentions and examined the relative predictive power of attitude, subjective norm and perceived behavioural control. Most often, researchers used direct measures for this type of analysis, but in a few cases they relied on summed belief indexes instead (see equations (3), (4) and (5)) Figure 5 shows the frequency with which different kinds of analysis methods were used in studies published between 2006 and 2020, while Figure 6 focuses on the five most frequently used analyses and displays the distribution of sample sizes by analysis type. The average sample size was taken when multiple models were estimated, for example, when data was collected in multiple countries or in different groups.

Inspection of Figure 5 reveals an increase of reliance on SEM over time to the point that it has become the standard method for estimating the relative impact of the TPB constructs on intention. Thus, researchers increasingly model these constructs as latent variables using mostly reflective indicators.

Beginning in 2017, some authors started to apply the nonparametric and variance-based SEM-PLS (partial least squares) method. In comparison to SEM-CB (covariance-based), reasons to apply SEM-PLS are non-normal data, small sample sizes and the use of formative indicators (Hair *et al.,* 2019). The boxplots in Figure 6 suggest, however, that sample size does not play a large role in choosing either SEM-CB or SEM-PLS to analyse the data. Among investigators using SEM-CB and reporting low sample sizes, a few mentioned explicitly that they were aware of potential estimation problems and used approaches needing less information or applied bootstrapping.

One recent article (Daxini et al., 2019) reported the use of latent class modelling to take into account heterogeneity of samples and estimated the effects of attitude,

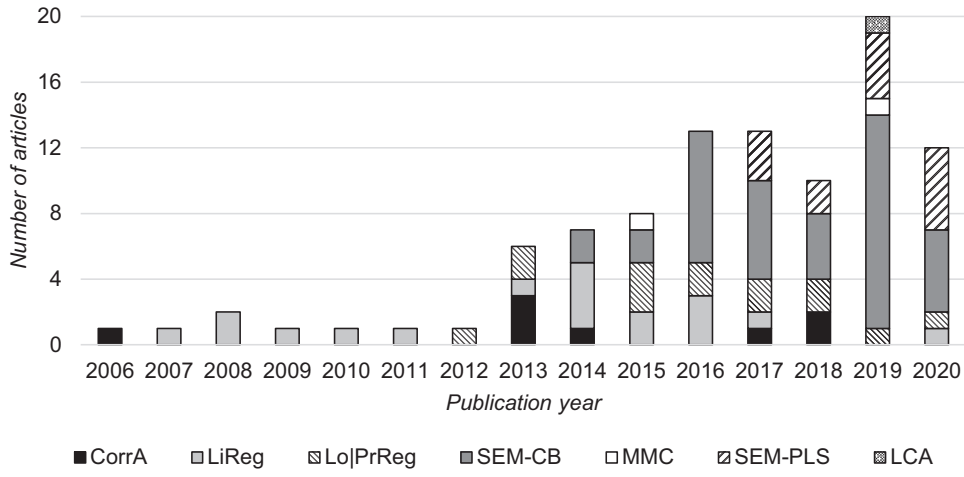

Figure 5. The use of analysis methods between 2006 and 2020 to assess the relative impact of TPB constructs on intention. *Notes:* CorrA = Correlation analysis, LiReg = Linear regression, Lo|PrReg = Logistic or probit regression, SEM-CB = Structural equation modelling covariance-based, MMC = Mean or median comparisons, SEM-PLS = Structural equation modelling partial least squares, LCA = Latent class analysis.

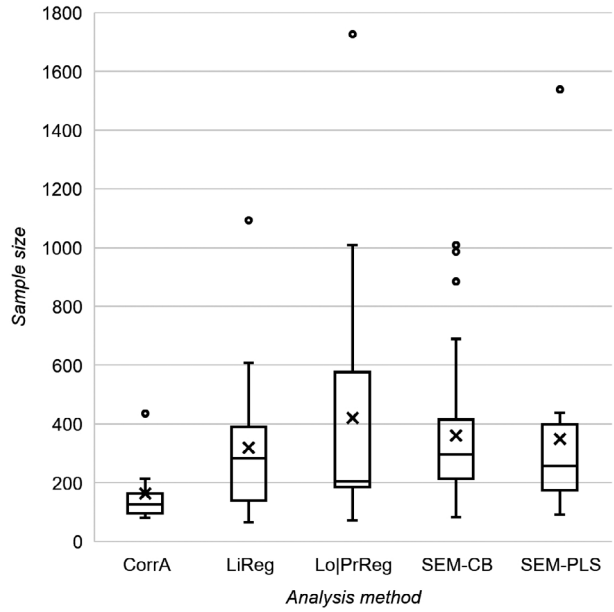

Figure 6. Boxplot of the distributions of the sample size for five groups using different methods to assess the relative impact of TPB constructs on intention (crosses represent the means).

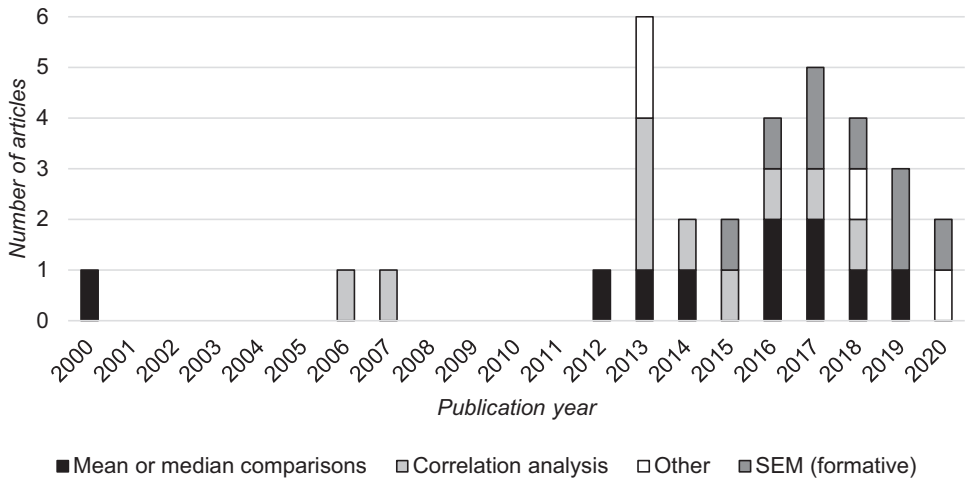

Figure 7. The use of analysis methods between 2000 and 2020 to assess the most influential beliefs.

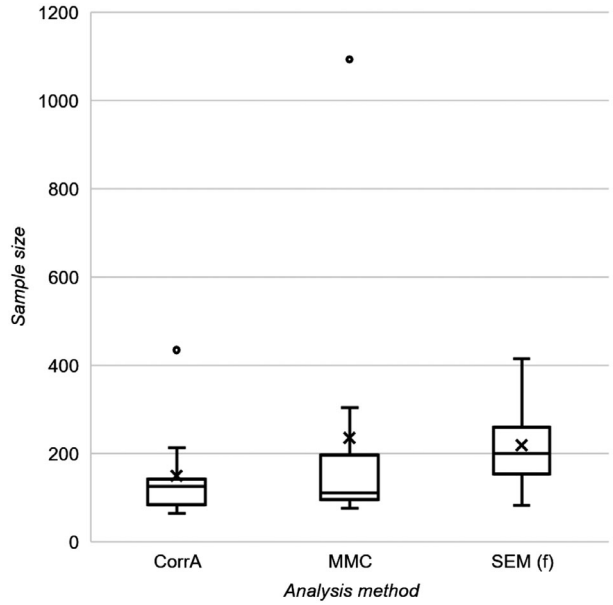

Figure 8. Boxplots of the distributions of the sample size for three groups using different methods to analyse influential beliefs. *Notes:* The crosses represent the means. CorrA = Correlation analysis, MMC = Mean or median comparisons, SEM (f) = Structural equation modelling (formative).

subjective norm and perceived behavioural control on intention for three different classes, representing different farmer typologies.

5.5. Analysing influential behavioural, normative and control beliefs

To examine how investigators handled identification of important behavioural, normative and control beliefs, we selected all articles that reported assessing these beliefs. Figures 7 and 8 provide information about the analysis methods used in a manner parallel to Figures 4 and 5. Of the 32 eligible articles, 20 analysed the most influential beliefs by mean or median comparisons (MMC) or correlations, thereby making no assumptions about the direction of the relationship between indicators and their underlying construct. When using the MMC analysis method, respondents are divided into groups, often two groups consisting of low-intenders and high-intenders, and the mean or median scores of the beliefs in these groups are evaluated for statistical differences. When using correlation analysis, each belief is correlated with the direct measure of its underlying construct or with the measure of intention. When excluding the outlier in the MMC group, the average and median sample size across these 20 articles ($M = 146$; Md = 117) is lower than the sample sizes in the articles reporting the use of formative SEM models ($M = 220$; Md = 200).

In the category 'Other', two articles inferred the relative importance of individual beliefs by means of a principal component factor analysis, assuming a reflective model in which the beliefs are a function of the latent variable (principal component) assuming no random measurement error of the items to measure beliefs (Brown, 2015). As

Table 3
Classification of selected articles ($n = 35$) based on their reporting of the variance in intention explained and how additional predictors were inserted in regression models

Reporting of the variance in intention explained		Additional predictors regressed on:	Intention	Direct measures of TPB predictors	Both	
Standard TPB model	Extended model					
No	No		4	1	1	*6*
	Yes		11	2	2	*15*
Yes	No		0	2	0	*2*
	Yes		8	0	4	*12*
		Subtotal	*23*	*5*	*7*	*35*

of 2015, researchers have begun to use formative SEM models to assess the belief structure. So-called MIMIC (multiple indicators multiple cause) model structures were most often employed. In a MIMIC model, beliefs (indirect measures, formative indicators) are regressed on their construct, whereas these constructs are modelled as latent variables, represented by direct measures (reflective indicators).

5.6. The sufficiency assumption and additional predictors of intention

Additional predictors of intentions to the basic TPB model are frequently added to test the sufficiency assumption, that is, to see if these added predictors can account for unique variance in intention. We selected the 35 articles that included direct measures of the TPB constructs as well as additional predictors of intention and that employed a regression technique. Three quarters of these articles (26 of 35) have been published in the last few years, as of 2017. The predictors most often added were self-identity and several types of norm, such as group norm, moral norm or personal norm. In a number of articles, additional predictors were selected from other established social-psychological theories, such as Davis's technology acceptance model, Rosenstock's health belief model, Schwartz's norm activation model, and Stern's value-belief-norm theory.

As can be seen in Table 3, in about two thirds (23 of 35) of the studies, the additional predictors(s) were regressed on intention and, of these, only 12 reported the amount of explained variance in intention for both the standard TPB model and an extended model that included the additional predictors. The unique variance in intention explained by selected additional predictors in these 12 articles is shown in Table 4.

5.7. Background factors

In the TPB, background factors – such as demographic characteristics or individual difference variables – are expected to influence intentions and behaviour only indirectly by their effects on behavioural, normative and/or control beliefs or by moderating the relations among the theory's constructs. In the studies reviewed, investigators

Table 4
Overview of the variance in intention explained by the standard TPB model and an extended model of 8 out of 35 selected articles that reported the unique variance of additional predictors

Authors	Farm management aspect studied	Analysis method[a]	Additional predictors[b]	Variance in intention explained		Models compared?
				Standard TPB model	Extended model	
Lokhorst et al. (2011)[c]	Participation in agri-environmental schemes	LiReg	Personal norm, self-identity	0.37	0.40	Yes
Lokhorst et al. (2014)	Land and landscape	LiReg	Connectedness, place attachment, self-identity	0.47	0.62	Yes
Mastrangelo et al., 2014	Land and landscape	SEM-CB	Awareness, Personal norm	0.41	0.31[d]	No (not nested)
van Dijk et al. (2015)[c]	Participation in agri-environmental schemes	LiReg	Group facilitation, group identification, group norm, self-identity	0.48	0.50	Yes
Sharp and McLeod (2016)	Animal welfare	LiReg	General attitudes, knowledge, past behaviour	0.45	0.52	Yes
Maleksaeidi and Keshavarz, (2019)	Land and landscape	SEM-CB	Knowledge, moral norm	0.53	0.67	No (not nested)
Rezaei et al. (2018)	Biosecurity and disease control	SEM-CB	Knowledge, moral norm	0.41	0.57	Yes
Rezaei et al. (2019a)	Biosecurity and disease control	SEM-CB	Ascription of responsibility, Awareness, Personal norm	0.42	0.57	Yes

Table 4
(*Continued*)

Authors	Farm management aspect studied	Analysis method[a]	Additional predictors[b]	Variance in intention explained: Standard TPB model	Variance in intention explained: Extended model	Models compared?
Rezaei et al. (2019b)	Occupational safety and health	SEM-CB	Perceived susceptibility, Perceived severity	0.43	0.54	Yes
Wang et al. (2019b)	Water and irrigation	SEM-PLS	Perceived vulnerability, Perceived Severity, Response efficacy, Response costs	0.31	0.37	Yes
Khan et al. (2020)	Biosecurity and disease control	LiReg	Knowledge, moral norm	0.22	0.31	Yes
Savari and Gharechaee (2020)	Occupational safety and health	SEM-PLS	Moral norm, risk perception	0.69	0.80	No

[a]LiReg = Linear regression, SEM-CB = Structural equation modelling covariance-based, SEM-PLS = Structural equation modelling partial least squares
[b]The underlined predictors significantly explained unique variance in intention.
[c]Multiple models estimated, so averages were taken.
[d]'Explained variance of this model was 10% lower than the TPB due to a more indirect influence of social norms on intentions' (Mastrangelo et al., 2014).

examined primarily properties of the individual farmer or of the farmer's group as potentially important background factors.

We selected the articles that included measures of background factors and employed a regression technique. The role accorded to background factors in the analytical models was often not clear. Figure 9 visualises the ways in which background factors were inserted in the models. It can be seen that the majority of the selected articles (61%) regressed the background factors directly on intentions. In six studies, background factors were correlated directly with behaviour. It would be appropriate from a theoretical perspective to insert background factors at the level of intention as interaction effects with the variables representing the theory's predictors. Instead, however, they were mostly treated as covariates or main effects, rarely as moderating variables. In six articles, the background factors were regressed on the direct measures of attitude, subjective norm and perceived behavioural control, mostly using path analysis with or without latent variables. Remarkably, only three studies examined the effects of background factors on beliefs, the theoretically most relevant question.

6. Discussion and Recommendations

Our systematic literature review focused on how the theory of planned behaviour, a reasoned action model, is applied to farmer behaviour. In the 124 articles selected for review, the TPB was applied across a broad range of farm management aspects, mostly relating to 'land and landscape' and 'biosecurity and disease control' issues. We now summarise the key findings, provide an overall evaluation of the current state of affairs and offer recommendations for future research.

In a small fraction of the studies assessed (7%), we did not find any measures (direct or belief-based) of attitude, subjective norm and perceived behavioural control, calling into question the authors' claims that they applied the TPB. Of the studies that did assess the theory's predictors, direct measures were more often used than indirect (belief-based) measures (70 vs. 48%). The assessment of beliefs in accordance with the expectancy-value models of attitude, subjective norm, and perceived behavioural control requires a pilot study prior to the main study and demands space in the resulting survey instrument. These additional demands notwithstanding, we make a plea for belief measurement, especially when the research objective is to develop and/or

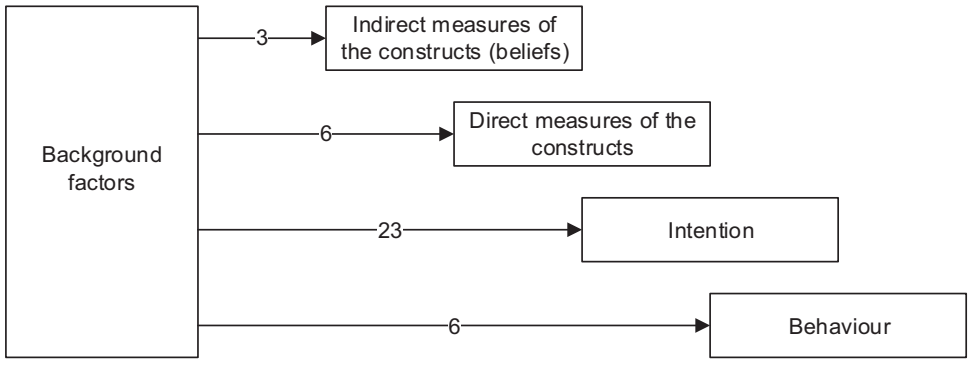

Figure 9. The ways in which background factors were inserted in regression models to assess their impact on behaviour.

evaluate agricultural policy interventions, for example, voluntary participation in agri-environment-climate measures or eco-schemes (European Union, 2019). Information about beliefs is critical for explaining a given behaviour and because interventions must target the beliefs that ultimately guide farmers' behavioural decisions (Ajzen, 2011) . *For the statistical analysis of beliefs, we encourage researchers to familiarise themselves with the distinction between reflective and formative indicators of latent theoretical variables*.

Application of the TPB also requires adherence to the theories' guidelines for design and measurement. Our review clearly shows the importance of maintaining compatibility among measures of the theory's constructs. Studies that adhered to the principles of construct and scale compatibility explained significantly more variance in intentions than did studies that failed to do so. Unfortunately, in only 33% of the reviewed articles were constructs measured in line with the principle of compatibility. This observation is consistent with recent reviews of reasoned action models applied in other domains (Scalco *et al.,* 2020; Yuriev et al., 2020).

Many studies tested an extended model of the TPB in which one or more potentially relevant predictors were added to the standard constructs. Self-identity was a frequently selected candidate for testing the theory's sufficiency assumption. Indeed, it has been argued that self-identity is an important construct to explain (farmer) behaviour in different domains (Burton and Wilson, 2006; Rise *et al.,* 2010; McGuire *et al.,* 2013; Hyland *et al.,* 2016). In assessing the sufficiency assumption, the variance in intention explained is mostly used as the index of model fit in (linear) regression models. However, in only 12 of the eligible 35 articles was the explained variance reported for both the parsimonious TPB model and the 'extended' model, making it possible to report the increment in explained variance due to the additional predictor (s). *We recommend that researchers aiming to test the role of additional predictors report the increment in explained variance*.

Another key observation has to do with the way in which background factors were treated in many of the reviewed studies. Demographic characteristics and other individual or social variables are often added arbitrarily to the TPB's constructs in an additive manner, without proper tests of the theory's central hypotheses. In the TPB, background factors can be used to account for the origin of beliefs and they may also be hypothesised to moderate the relationships among theoretical constructs. Instead of testing these aspects of the theory, in the majority of reviewed articles (61%) background factors were included as direct predictors of intention. As Hennessy *et al.* (2010) observed, it seems that the TPB is sometimes 'not taken seriously as both the basic theoretical and analytic model', but only as 'an elaborate method of identifying a list of possibly relevant variables'.

We recommend two types of analyses to explore the role of background factors in the TPB. First, *the fully mediated model predicted by the theory should be tested against a partially mediated model allowing direct effects on intention*. Second, in the most recent conceptualisation of the TPB, the effects of attitude and subjective norm on intention are assumed to be moderated by perceived behavioural control, as is the effect of intention on behaviour. These hypotheses require testing the relevant interaction terms. With the increasing use of structural equation modelling to analyse TPB data, sophisticated estimation strategies are available to test the predicted mediation and moderation effects (see, e.g., Baron and Kenny, 1986; Hayes, 2018). Researchers should be aware that more complex models often require larger samples for detecting significant mediation and moderation effects. A power analysis for structural

equation models can indicate the number of respondents needed to obtain statistically significant parameter estimates. However, prior to obtaining sufficient respondents, the first step is to ensure measurement model quality by adhering to the TPB guidelines, so as to minimise measurement error and biases.

Generally speaking, our review of research on farmer behaviour has shown that guidelines on how to apply the TPB are widely ignored, resulting in serious conceptual and methodological problems. Some or even most of the theory's constructs may not be assessed, making a proper test impossible; the principle of compatibility is not observed, impairing the theory's predictive validity; new predictors are proposed without testing the amount of additional variance in intention and/or behaviour that can be explained by these variables; and background factors are treated as direct predictors of intention or behaviour when their effects are expected to be mediated by the theory's proximal predictors or to moderate the relations among the theory's constructs.

These various issues seriously jeopardise our ability to derive valid conclusions from TPB-based research on farmer behaviour. When the theory's constructs are not properly operationalised and the model is not tested correctly, we are unlikely to obtain reliable information about the relative importance of attitudes and subjective norm as determinants of intentions; about the power of perceived control to moderate the influence of attitudes and subjective norm; and about the predictive validity of intentions in relation to actual behaviour. Moreover, because in most studies beliefs are neither elicited nor assessed, the research cannot provide information about behavioural, normative and control beliefs on which attitudes, subjective norm and perceptions of control are based. Information about beliefs is essential for a full understanding of farmer behaviour in the context of the TPB and for the development of effective behaviour-change interventions.

Supporting Information

Additional supporting information may be found online in the Supporting Information section at the end of the article.

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