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Finding the ecological farmer: a farmer typology to understand ecological practices within Europe

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Abstract:

Agricultural policies are now being directed towards carbon reduction and reversing the decline in biodiversity, whilst sitting alongside food production goals. Increasing the uptake of ecological approaches is expected in numerous policies but there is evidence of only marginal adoption. Uptake is contingent on farmer acceptability of these methods and we explore a range of perspectives towards ecological farming within a cross-European survey. We apply a one stage latent class approach to identify homogenous groups with similar identities and examine common factors which may correlate to farmer membership of a particular group. We find two groups which reveal a strong identity towards ecological approaches but are mainly differentiated by informal and formal institutions, such as social pressure and acceptance within the supply chain. These types are found to be active towards uptake of ecological approaches. A further group reveals evidence of a multifunctional identity, whereas a final group tend to show indifference towards ecological approaches which may align with previous identifiers as productivist farmers. As Governments are seeking to promote transition within the industry we argue for clear policy intent in payment regimes and regulations, as well as holistic approaches to institutional structures to target particular groups of farmers for real behavioural change.

1. Introduction

Growing societal concern towards the environmental damage caused from current systems of food production are leading to a more explicit change in the ambition for agricultural policy (European Commission, 2020; Bhattacharyya et al., 2020, Schebesta and Candel, 2020). Mainstreaming more environmentally friendly farming methods is now explicit in these policies and this reflects a greater desire for transition towards sustainable food production. A number of documents herald an ambition to increase the uptake of ecological practices within farming within Europe. For example the EU's Farm to Fork Strategy promotes a vision for reversing biodiversity loss, reducing agrochemical use and limiting unsustainable protein imports (European Commission, 2020). The UK's recently launched Environmental Land Management System (Defra, 2021) also promotes ecological practices to replace agro-chemical inputs and meet climate targets through promotion of practices such as cover cropping and farm woodland cover. Ecological practices comprise solutions working within nature to support the wider ecosystems services from the farm, but also provide a way to support food production and economic needs (Soule and Piper, 1992; Bockstaller *et al*., 1997; Robertson *et al*., 2014). Central to achieving these visions are the perspectives of farmers and farm communities who may either accept or reject these new standards of practice within their own farming system.

A number of authors have explored and classified farmer perspectives against a number of environmental concerns (Guillem *et al*., 2012; Daxini *et al*., 2018). These studies tend to find farmer types inhabit a spectrum from production to conservation orientations, finding pockets of farming practice or perceptions which align to a more environmentalist outlook, compared to those who remain solidly productivist (Barnes *et al*., 2011, Sutherland *et al*., 2019; Hyndland *et al*., 2018; Barnes and Toma, 2012). Perceptions towards ecological practices have been less explored in detail but a number of authors have shown how farms can be classified across a discrete trajectory from conventional to a state of agro-ecology through the addition of successive sets of wider practices (Duru *et al*., 2015; Trabelsi *et al*., 2016). The link between these perspective types and attitudes has also been found to be significant in determining participation within agri-environmental or organic schemes (Sulemana and James, 2014; Cullen *et al*., 2020). Overall, the nature of the transition to ecological practice adoption is driven by constraints both from within the farm, but also outside the farm, in terms of social acceptance and how farmer perceptions meet or conflict with internal belief systems (Toma *et al*., 2018; Kuehne *et al*., 2017; Defrancesco *et al*., 2008).

One parsimonious approach to understanding the mixture of motivates and perceptions of farmers is the concept of farmer identities which has been usefully applied to the adoption of environmental practice (Burton and Wilson, 2006; McGuire *et al*., 2013; Groth *et al*., 2014; McGuire *et al.,* 2015). Identity theory posits that individuals have multiple identities based on their social networks and social standing (Burke and Stets, 2009). There will be a salient identity which will determine how an individual will act and which will be observed within a specific situation (Stryker and Burke, 2000; Burke and Stets, 2009). The 'productivist' identity seems to dominate these studies, which have been applied to regionally distinct case studies (Burton and Paragahawewa 2011; Reimer et al., 2012). However, there is also recognition that farmers hold awareness of the damaging effects of their practices which may support or question their productivist stance (McGuire et al., 2013). Whilst these studies argue that social standing is usually more important than environmental concern in shaping these identities, Sulemana and James (2014) argued that ethical attitudes of farmers are composed of both farmer identity and farmer and farm characteristics. Accordingly personal, along with social, factors are also crucial in determining salient identities, and parallels may lie in the work of Bogardus on the psycho-social investigation of social-distance (Wark and Galliher, 2007). This refers to the *'grade and degrees of understanding and intimacy which characterise pre-social and social relations generally*' (Bogardus, 1992). A number of studies have found evidence of social distance across a range of areas, such as consumer choice, (Zhang and Li, 2008), eco-volunteering (Woosnam and Lee, 2011) and perspectives on climate change amongst farmers (Barnes *et al*., 2013). Sun *et al*. (2017) found as social distance increased more risk aversion within an individual occurred. Accordingly, with respect to decision making both social distance and identity theory can be usefully applied to farmers who may occupy a post-productivist space.

Classifying farmers on their dominant personal beliefs and social standing also provides a practical approach to informing policy. A common argument for exploring a discriminating schema for farmer perspectives is that it allows more focused interventions (Schmitzberger *et al*., 2005; Barnes *et al*., 2011; Hyndland *et al*., 2018; Daxini *et al.*, 2019) and therefore cost effectiveness will increase compared to blanket approaches. Scalability of these types and how they apply to the wider agricultural population are also gateways for intervention to support transition (Guillam *et al.,* 2012; Daxini *et al*., 2018; Cullen *et al.,* 2020). This would seem a crucial application of typology work, given the proposed shifts emerging from agricultural policy, as well as the significant expense of administering agricultural support programmes in Western economies. Moreover, the spectrum of systems that now exist within farming tends to challenge the linearity of the productivist-post-productivist continuum (Wilson, 2001) and indeed now, after decades of agri-environmental interventions, offer what Saunders (2016) refers to as shades of green. Accordingly, it is important to redefine our baselines around this heterogeneity and ask how these groups are shaped by current institutional factors, as well as personal beliefs and attitudes to adoption of ecological practice.

This paper aims to provide a classification of dominant farmer types with a view to informing future policies that promote ecological practices within farming. We develop this typology based on individual perspectives towards ecological practices and further estimate these on main descriptors available in farm databases to allow mapping of these identities at a wider scale. We do this using a bespoke survey of farmers across a number of selected European countries, thus reflecting different environmental and institutional conditions, and apply a one stage latent class analysis to both define our classes and explain the effects of farm characteristics on shaping membership of these classes.

The paper is structured as follows. The relevant past literature on sustainable identities is reviewed to develop a conceptual framework for composing these types and understanding what factors condition a farmer to adopt such an identity. Then the data are described along with the methodological approach to estimating these ecological identities. Results are presented of the final classification and factors behind membership of each class. A discussion reflects on these results and wider conclusions are drawn for agricultural policy aiming to support transition to more ecological practice.

2. Conceptual Framework

Deriving a dominant farmer type

Practice based typologies have been proposed for a number of years (Kostrowicki, 1977; Duvernoy, 2000; Nyaga *et al*., 2015), ostensibly attempting to codify practice from conventional to less intensive and organic systems (Schmitzberger *et al*., 2005). Typologies attempting to capture the heterogeneity of farmer motivations and perceptions are relatively more recent (Brodt, 2006; Emtage et al., 2006; Davies and Hodge, 2007; Gorton *et al*., 2008; Daloğlu et al., 2014). These tend to focus on particular aspects of natural resource management pertinent to the farm such as water quality management (Barnes *et al*., 2011; Daxini *et al*., 2019) and greenhouse gas mitigation (Barnes and Toma, 2012; Arbuckle *et al*., 2017; Hyndland *et al*., 2019). Generally these studies tend to find a variety of types which evolve from a more commercial or conventional identity to an array of ethical or environmental stances which predicate adoption of ecological practices (Darnhofer et al., 2005). These perspectives are composites of a number of domains of influence, including the formal and informal institutions around the farmer and personal beliefs and motivates. One criticism is their relatively static and time dependant nature. Identities are not fixed and may to some degree be an artefact of the environment in which empirical investigation occurred. Davies and Hodge (2012) and Guillem et al. (2012) found their types to be robust over time, but observed changes in membership to more productivist orientations. This may have been influenced by changes in the institutional environment.

The social influence of other farmers emerges quite strongly within the literature, identifying wider social networks affecting ecological practice approaches (McGuire et al., 2013). Bakker *et. al* (2021) found the perspectives of other farmers influenced the intention to reduce pesticide use for farmers in the Netherlands. Cullen *et al*., (2020) identified a significant and large neighbourhood effect on adoption of agri-environmental schemes in Ireland. Michel-Guillou and Moser (2006) examined the differences between conventional and environmental practice adoption, finding social factors, including public image, to be important in influencing farmer decisions around environmentally friendly practices. Sulemana and James (2014) further explored the prevalence of an ethical attitude on identity formation within US farmers. They emphasised the importance of outlooks, such as 'optimistic versus pessimistic', that would lead to membership towards a more ethical and conservation orientated group.

Whilst a key economic influence, very few studies have identified the supply chain influence on either limiting or enabling the ability to adopt ecological approaches (Sellitto et al., 2018). This would seem a key issue around adoption and the more softer elements around trust and long term relationships between farmers and buyers have been found to influence adoption of ecological practices (Naspetti *et al*., 2017; Hansson *et al*., 2019; de Sá *et al*., 2019).

Against more personal factors, a range of studies have linked decisions to promote ecological approaches such as alley cropping and integration of trees or reducing dependence on external fertilisation regimes with more 'entrepreneurial' attitudes (Mary *et al*., 1998; Barnes *et al*., 2009; Bartkowski and Bartke, 2018). Lequin *et al*. (2019) identified both profit goals and farmer expectations as key leverage points for engagement in environmental conservation schemes. Farmer goals towards the business and lifestyle factors tend to influence the decision to adopt more ecological schemes. Guillem *et al*. (2012) applied a typology to a Scottish catchment based on attitudinal surveys towards perception of their environment (e.g. birds and agri-environmental schemes). They found, compared to profit-maximising types, the role of hobbyists and multifunctional behaviour supported more engagement in agri-environmental schemes.

Information support and knowledge capacity are also key to uptake of ecological practices. Upadhaya *et al* (2021), within an annual survey of farmers in the corn belt of the US, identified a 'deliberative' group who were amenable towards conservation approaches but had high perceived barriers towards practice adoption which the authors argued was a perceived lack of knowledge or economic or agronomic capacity. Similar issues around lack of access to knowledge of ecological approaches and constraining economic factors have been identified in a number of studies (Garforth et al., 2004; Power et al, 2013; Dessart et al., 2019). With respect to this McGuire *et al*. (2013) conceptualised a continuous feedback loop which, they argued could be found in performance metrics based on environmental management, as a way to activate and validate their conservationist farmer identities. Accordingly knowledge and the capacity to adapt may also be crucial in determining a particular ecological identity.

Shaping ecological types

Various conditioning factors have to be considered in terms of their influence on overall membership or otherwise of a particular class. Identifying the covariate structures behind these types is a critical step towards mapping these identities across a regional strata and onto administered data sets (Guillem *et al*, 2012). One aspect of this is the engagement in environmental schemes, in particular to transition to organic which embodies some of the principles of an agro-ecological approach. Past literature has found a distinction between productivist and conservation types based on membership or willingness to transition to organic production within farming communities (Jacobsen *et al*., 2003; Schmitzberger *et al*., 2005; Darnhofer et al., 2005; Guillem and Barnes, 2012; Dessart *et al*., 2019) .

More structural factors would also have an influence in forming an ecological identity. In terms of the whole system whether the farmer is managing a specialised farming unit or has switched to mixed farming methods has been found to predict ecological approaches (Horlings and Marsden, 2011; Schoonhoven and Runhaar, 2018; Kleijn et al., 2019) . A more mixed approach allows for circularity of inputs within the farm gate and reduces dependency on external inputs. We would hypothesise that mixed farmers are more likely to hold a stronger ecological identity than specialised farmers.

The management structure of the farm or holding will reflect decision making towards ecological practice and whether this is a sole or joint decision. Similarly, household size has been found to be a positive factor for change in practices which reduce agrochemical use (Karali et al., 2014; Bouttes et al., 2019; Home et al., 2019). In addition, the control of land, through the level of ownership, compared with tenanted farmers, is also critical especially for longer term decisions such as planting woodland. Borremans *et al*. (2016) found land tenure, and the conditions around the tenancy agreements as a drawback for engaging in agro forestry schemes within a cohort of Flanders farmers. A similar effect was identified by Beer and Theuvsen (2019), in terms supporting or constraining the decision to diversify into non-farm activity.

A related aspect of this is the role of farm size as an enabler for adoption of ecological methods, with the literature finding that larger farmers were more willing to seek conservation solutions (Kareli *et al*., 2013; Kleijn *et al*, 2019; Prokopy *et al*., 2019; Ma and Abdulai, 2019).

Gender of the main decision maker has also merited exploration as a significant conditioning factor for determining ecological practice (Brasier *et al*., 2014). Franzen *et al*., 2016 found higher willingness to participate in AES for wetlands management in males compared to females, which they attributed to potential for females to manage particular farm types in Sweden. Mzoughi (2011) also found some effect of female ownership on integrated crop protection but not for organic production.

Years of experience, as an alternative to age and education, is preferred as these have been found to have mixed effects on practice adoption and also seem to correlate as higher education becomes more ubiquities with younger age groups. In addition, years of experience provide some insight into family life cycle factors (Potter and Lobley, 1996; Burton, 2006) but also offer a leverage point for policy which seeks to promote new entrants as well as succession planning within its support frameworks.

Finally, Knowler and Bradshaw (2007) identified the localised effect of factors which may or may not affect conservation agriculture. However some cross country studies have found commonality in identities (Gorton *et al.,* 2008; Prokopy *et al*., 20I9). In a study of 10 European countries and their adoption of organic farming methods, Casagrande *et al*. (2016) found country level differences in the types derived which they proposed reflected the difference climate conditions, but also institutional barriers to adoption in several of these countries.

Accordingly, in compiling ecological farming identity both formal institutions in terms of payment schemes, regulatory compliance, and requirements from within the supply chain, and informal institutions, such as farmer social networks, along farmer led goals are critical in forming an ecological farming identity. A path diagram is shown in Figure 1. This places key motivational statements to constructing these identities but also the conditioning variables, related to farmer and farm characteristics based on the conceptual framework above.

Figure 1. Path diagram of latent class model of Ecological types with covariates

3. Methods

Data Collection

A survey was administered to participants across a number of European countries, representing a mixture of environmental and biophysical conditions. The main purpose of the survey was to gather in-depth information around ecological practices within European farming and aimed to stratify against farm size, gender and income indicators within each participating country. Data were collected as part of the EU LIFT project and administered by national institutions in their home language with the aim of capturing a representative sample of each nation's farming systems. A mixture of data collection techniques were used, including face to face, telephone and web survey collection.

The questionnaire consisted of a number of sections which covered the characteristics of farming systems, the adoption of ecological practices and detailed motivations for their adoption administered as likert scales. The survey once developed, was first piloted within each country to test appropriateness of questions and regional understanding. Several alterations were made around clarity of practice definition and definitions to FADN variables . The main survey was conducted from September 2019 to March 2020 across Europe and compiled within a local database by a single group to avoid coding errors and harmonise indicators. Extensive data cleaning and coding was then performed to ensure these data offered a reflection of each participating country's farming system. Table 1 shows the distribution of responses by main descriptive statistics categorised by each country and overall averages.

Table 1 Main Descriptive Statistics of the EU sample

Estimation Approach

We employ latent class analysis (LCA) to derive our typologies (Lazarsfeld and Henry 1968; Vermunt and Magidson, 2002). Within agriculture and farming a number of studies have adopted this approach (Barnes et al., 2013; Arbuckle, 2017; Daxini et al., 2019; Botero et al., 2021). LCA assumes that there is an underlying latent categorical variable that divides into discrete classes based on a series of measured items, in our case the responses to a set of statements. This classification is performed under the assumption that the number of classes is known *a priori*. In order to understand the conditioning factors on membership the classes developed can be regressed through a multinomial regression, in which the classes are handled as independent and discrete groups. This can be achieved as either a single stage (1-step) or a multi-stage (3-step) estimation. The former is preferred as the 3-step approach can lead to biases in estimation of the typology (Bolck et al., 2004; Croon, 2002).

The covariate effects are estimated simultaneously as the parameters defining the class specific distribution. This is shown below which models jointly the probability of class probabilities and those covariates which explain membership ($P(Y_i|Z_i)$):

$$P(Y_i|Z_i) = \sum_{t=1}^{T} P(X = t|Z_i)P(Y_i|X = t) \quad (1)$$

where *Y* is the full response vector of each statement across farmer *i*. The discrete latent class variable (*X*) has a particular class denoted by *t*, with the total number of classes denoted by *T*. We assume the Y_i is independent of the covariates (Z_i) conditional on *X* to infer heterogeneity of response. This will lead to the probability of the covariates influencing membership of a latent class (*t*) and parameterised through a multinomial regression model (Vermunt, 2010; Lanzer and Rhoades, 2013).

The LCA and covariates were estimated in a single stage using the poLCA package (Linzer and Lewis, 2011) in R v.4.04 (R Core Team, 2020) which accommodates categorical data. In order to allow convergence, we set the maximum number of iterations to 10,000, we also set the value for starting estimates to run for 3,000 repetitions. This allows the starting values to reach global rather than local maximum of the log-likelihood function. The statements, developed from the conceptual framework outlined above, and used to derive the LCA are shown in Table 2.

Table 2. Statements used within latent class analysis and descriptive statistics

4. Results

4.1 Number of classes

Classes are iteratively added to the model and a typology is performed for each iteration. The LCA was estimated with 1 to 6 classes and the resultant identification statistics presented in Table 3. As LCA is based on a maximum likelihood estimation approach, the optimal number of groups in the sample is the one which minimizes values, in particular the Bayesian Information Criterion (BIC) (Nylund, 2007). The BIC minimises at 4 classes. Similarly the log-likelihood shows a more marginal decrease after 4 classes. Entropy values range from 0 to 1 and higher values indicates a better classification (Williams and Kibowski, 2016).

Table 3. Number of classes and the resultant identification of optimal classes

The conditional probabilities by latent class are presented in Table 4. These are shown as heat diagrams to aid understanding. These indicate the probability of membership to a particular class based on that member's response to each statement. These sum to 1 across each row with each class and higher proportions indicate higher probability of agreement across the individual statement scale. Hence the level of agreement or disagreement within a particular class can help to profile the class itself. More descriptive analysis is provided below.

Table 4. Distribution of conditional probabilities and response per latent class

Class 1 Enabled Ecologists. This class is characterised by high probabilities that they will strongly agree with the farmer outlook statements, indicating their self perception as positive and ecologically aware farmers. Members of this class will also be likely to have high levels of agreement with goals of adopting farming methods that promote social and environmental benefits, as well as enabling monitoring of their farm performance. In addition, they have the highest probability of agreement with statements around supply chains. This tends to infer members of this class have a good working relationship with their buyers and are enabled when adopting ecological practices. Moreover, they are also likely to have the highest level of disagreement to goals which link ecological practices with agricultural productivity. Notably, they offer a more diffused set of responses to questions on social acceptance which may infer their adoption of ecological practice is socially marginalised.

Class 2 *Constrained Ecologists*. Compared to the enabled ecologist class they have more diffused probabilities of agreement with farmer outlooks towards the environment. Notably, they have the highest probability around willingness to adopt technologies if they are seen as innovative, which may also align with their likely agreement that few farmers are adopting ecological practices. However, as opposed to Class 1, members of this class tend to have higher probability that they tend to disagree with statements on access to knowledge networks and supply chain support for their methods. In particular, they are more likely to identify a lack of supply chain support to adopt ecological practices. This class may reflect an attitudinal stance which is amenable to adoption of ecological approaches but feel constrained by lack of support through supply chains to enable the transition towards more ecological approaches.

Class 3 *Balanced Ecologists*. This class tend to have higher probabilities of agreement, rather than strong agreement, to most statements. They are likely to agree with farmer outlooks and goals towards the environment, and also on the need to continually monitor performance. These are less strongly committed response towards the remaining statements than the enabled or constrained ecologists. Instead a more mixed view emerges towards the statements on access to advice and knowledge, as well as supply chain enablement. Members of this class are likely to have a strong sense of belonging to the farming community, however other statements on social acceptance have more balanced probabilities between agreement and disagreement.

Class 4 *Unengaged*. This class mostly characterised by low probabilities towards agreement or disagreement with the statements. Only in terms of where environmental protection links with productivity goals are there some higher likelihood of agreement, as well as feeling they belong in the farming community. Accordingly, this class tends to indicate a lack of lack of engagement with ecological approaches generally.

The results of the covariate one-step estimation are shown in Table 5 below. These compare the descriptive variables against membership of the enabled ecologists as this class represent the highest level of commitment to ecology. Results are presented as first order estimates as well as their exponents to identify the odds ratios. For brevity we focus on odds ratios, which shows the relative likelihood of a variable influencing membership of a particular class. If the odds ratio is below one within a particular class then that variable will more likely indicate membership of the enabled ecologist class.

Table 5. LCA multinomial regression results, referenced against the enabled ecologists class, coefficients, odds ratios and significance

A variety of influences, both positive and negative, determine membership of a particular class. Odds ratios are below 1, where significant, on whether members of a particular class have participated in agri-environmental or organic schemes. This would seem reasonable as each class is compared against the enabled ecologists. The constrained ecologists have a lower odds ratio for farming systems. This indicates that the enable ecologist class are more likely to be mixed farmers and tends to agree with previous findings that mixed systems lead to wider ecological perspectives (Horlings and Marsden, 2011; Schoonhoven and Runhaar, 2018; Kleijn *et al*., 2019).

The gender variable indicates the main decision maker as being female compared to male. Only for the disengaged class is this significant and above 1. Hence, within this study, female decision makers are less likely to hold ecological attitudes compared to male decision makers. This result was found by both Brasier *et al. (*2014) and Franzen *et al*. (2016). A larger farm household size, where significant, may also positively influence ecological identity and tends to match previous findings from the organic literature as perspectives towards agrochemical use changes as the household grows (Karali et al., 2014; Bouttes et al., 2019; Home et al., 2019). The disengaged class tend to have a lower number of years experience, when compared to the enable ecologist. However, whilst significant, this is only a slightly marginal effect.

There are some differences in management structure, inferring the influence of decision-making on ecological identities. Compared to sole ownership, other forms of management may lead to more association with ecological identities. Similarly, the level of owned land to total land, for the balanced ecologists, reveals this class has less control over land than the enabled ecologists. In addition, the constrained ecologist class are more likely to have marginally greater land area than the enabled ecologists.

Finally, the effect of region is a strong determinant of class identity. The constrained class are more likely to be from Eastern Europe, compared to the enabled class. Those in the balanced ecologist and disengaged classes are less likely to be from Southern Europe compared to the enabled ecologists class. Finally, Eastern European farmers are more likely to be in the unengaged class, relative to the enabled ecologist class, whereas those from Southern Europe are less likely to occupy this class.

Table 6. Adoption of Selected Ecological Practices by class

Table 6 shows the relationship between stated adoption of selected ecological practices and the typology. Overall, across all classes the proportion of adoption is lower than the majority although adoption of these practices may be interrelated. In addition, higher proportions of adoption are observed for the most enabled class, Class 1. Moreover, the non-engaged class, Class 4, mostly show lower levels of adoption of these practices

5. Discussion

One of the main challenges for meeting policy goals is setting the appropriate mix of regulation and voluntary intervention that would sustain long term behavioural change. Unlike previous reform windows, farm policy is now operating within an environment of an heightened state of global emergency around climate and biodiversity loss which makes realising strategic goals for agriculture particularly acute. Past attempts at integrating the environment into farming have only been partially successful (Dupraz and Guyomard, 2019).

Accordingly, defining an ecological farmer identity would seem a necessary step to supporting change, but also to providing a baseline which examines how perceptions may change as more environmentally friendly goals are promoted through policy.

Targets are specified in the Farm to Fork strategy, for example a 50% reduction in chemical inputs by 2030(European Commission, 2020) , but the intervention routes to achieve these targets will effect the composition of the four attitudinal types identified here. For instance the use of more stringent regulation to meet environmental targets has mixed effects on farmer environmental motivations and, in extreme cases, leads to apathy or rejection of environmental goals (Barnes et al., 2013; Van Dijk et al., 2015; Daxini et al., 2018). Accordingly, the use of these farmer baselines, as a complement to more practice based targets, allows some monitoring of farmer engagement towards ecological goals. Ultimately, sustaining and augmenting ecological practices beyond subsidy support and regulatory requirements is a key aim when intervening in this sector, and a metric of farmer perceptions of ecological improvement would seem essential to supporting these goals.

Developing four different identities captures some of the heterogeneity in perceptions across Europe. Whilst we find most farmers perceive themselves to be part of the farming community there are few other similarities between our four farmer types. For two of these types there is an ecological outlook, but these are conditioned by perspectives towards the supply chain or more informal influences such as other farmers which are seen to either enable or constrain this identity.

The enabled ecologists feel supported within their supply chain, feel they belong in the farming community and have strong environmental outlooks. Participation in agri-environmental (AES) and organic schemes are characteristics that are more likely to predict this identity above others. Initial participation in these schemes may have elements of economic opportunism (Fish, 2003; Karali *et al*., 2014; Coyne *et al*., 2021) but then evolve into a deeper appreciation of the environment and farming (Riley, 2016). Cullen *et al*. (2020) found, for a large scale study in Ireland, that a stronger agreement on the benefits of AES resulted in a higher likelihood of participation. This infers that a pre-formed ecological identity leads to participation, but that participation also enables development of an ecological outlook when even economic motives are dominant. The salience of this identity may then increase as participation continues, knowledge is gained and by social engagement with similar farmers (Burton and Schwarz, 2013; Cullen *et al*., 2018). The development of more inclusive agri-environmental schemes, with separate tiers for levels of participation should accommodate routes to farmers as they develop their ecological identities and provides support through growing social norms (Taghikhah et al., 2021).

Farmers who are in the constrained class indicate that the influence of their peer networks limit adoption and acceptance of ecological approaches. A number of studies argue that social influences may explain unwillingness to adopt a post-productivist outlook in farming (Lockie, 2006; McGuire *et al.,* 2013). However, demonstration, through peer to peer networks, has been recognised as a motivator for encouraging positive behaviour change by exploiting these social influences (Ingram *et al*., 2018; O'Connor *et al.,* 2020). More recently, the concept of 'living labs' has emerged as a means to build on these peer to peer learning dynamics and create a stronger support community for farming practice and could be a way to embed more ecological perceptions between farmers (Almirall *et al*., 2012; Gamache *et al*., 2020).

Supply chains have been found to both enable and constrain the uptake of sustainable approaches (Smith, 2008; Memken et al., 2021; Taghikhah et al., 2021). A key difference between the constrained and the enabled classes is the relationship farmers have with buyers and other actors in the supply chain. Hence, a critical aspect for policy to change social norms would be how to engage those outside of farming (Kok et al., 2019). There are oppourtunities for developing or switching supply chains (Jarzębowski *et al*., 2020; Galli and Brunori, 2013; Kos and Kloppenburg, 2019) but engaging post-farm gate actors with farmers is a significant challenge that has to be addressed to support a transition to ecological practice adoption (Runhaar et al., 2017).

A third group were in agreement with most of the statements and this may be linked to the multifunctionlist perspective. These view their food production as only one part of a whole system which also includes activities to enhance the environment (Jongeneel *et al.,* 2008; Villamor *et al.,* 2014) as well as wider benefits for society and the rural economy. This perspective was recognised by Wilson (2001; 2008) who saw the multifunctional farmer as a way to challenge the linearity of the productivist/post-productivist schema observed in previous studies. A multifunctional identity has been found in a range of studies across various regional case studies (Barnes *et al*., 2011; Guillam *et al.,* 2012; Villamor *et al*., 2014; Howley, 2013; Saunders, 2016) and emerges as a common type to compare against conventional farmers. One characteristic of this type is the lower rate of owned to total land farmed, which has been found to be an actuator for seeking wider oppourtunities, as farming activity may be constrained by tenancy issues (Davies and Hodge, 2006; Barnes *et al*., 2020). Whilst balanced between ecological and other perspectives, compared to the previous types, these farmers do provide a positive outlook for policy as they emphasise underpinning food production with openness to adoption of environmental practices.

A final group shows no observable concern, who state no or little agreement or disagreement with most of the statements. This group is quite a distance compared to the other groups. Casagrande *et al.* (2016), in a study of organic practices in several EU countries, found a similarly indifferent group with no motivation or interest in the conservationist practices identified. An apathetic group were also identified by Barnes *et al*. (2011) when examining beliefs and attitudes to water quality. Against traditional typology nomenclature this group may be composed of aspects of the productivist or conventional types (Upadhaya *et al.*, 2021). This could be inferred from their low probability of engagement in environmental and organic schemes. As such they will provide a particularly intractable group for engaging with ecological issues. Hence, this may present some argument for exploring higher regulatory baselines. Although the transaction costs will increase, national agencies will be operating under a global emergency which may become an acute motivator to re-examine regulation in farming as a way to address the common problem of indifference or apathy to policy goals. This is not without hazards as Bartel and Barclay (2011) identified instances of game playing and regulatory aversion which may limit the effectiveness of raising regulatory baselines in farming. More starkly, Barnes et al., (2013) found regulation embedded resistance towards voluntary participation in environmental practices. Female farmers are more likely to be members of this class, compared to males. The literature for high income countries has found mixed results between gender and adoption of environmental management within farming (Brasier *et al*., 2014; Franzen *et al*., 2016; Brown *et al*., 2019). Partly this is due to the smaller component of women to male farmers across these countries but there are aspirations for more inclusion of female decision-makers within farming (Dunne *et al*., 2021).

The typology approach emerges as a useful tool to baseline and monitor progress towards a policy goal. That identities may be malleable and positive ecological identities allowed to emerge, if enabled, is also encouraging for shifting policy goals towards more ecological approaches. Across Europe we find pockets of multiple identities. Although we include external influences that have been found to directly influence attitudes, namely organic scheme certification and agri-environmental scheme participation as well as a regional dummy to reflect policy conditions, there may be other external factors which would lead to the shaping of a particular perspective. Accordingly, whilst we take a wholly quantitative measurement approach, the types would benefit from further discussion with farmers and related stakeholders, such as environmental NGOs, as a means to refine these further and translate the findings to a regional context. Moreover, comparing these types with selection amongst farmer groups would be the next step in ensuring that visions are aligned for enabling policy leverage.

Perhaps of interest to the present dialogue on Farm to Fork are lessons learned between the enabled and the constrained ecologists. The main constraint are issues within the supply chain, something which the CAP has failed to show much ambition towards addressing in the past, nevertheless an aspiration to change supply chains may lead to more enablement of ecological identities.

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Table 1 Main Descriptive Statistics of the EU sample

	Austria	Germany	Greece	England	France	Hungary	Ireland	Poland	Romania	Scotland	Sweden	Average
N	94	51	108	67	229	120	33	100	52	113	184	105
Distribution of Sample	*8%*	*4%*	*9%*	*5%*	*18%*	*10%*	*3%*	*8%*	*4%*	*9%*	*15%*	*8%*
Total Agricultural Area(ha)	36.4	67.2	7.5	301.8	110.1	331.6	50.4	15.1	12.9	340.9	172.6	131.5
SD	*16.6*	*51.8*	*16.6*	*374.2*	*69.7*	*491.6*	*31.3*	*14.9*	*17.2*	*448.7*	*808.0*	*212.8*
Owned to total land (%)	61%	56%	82%	65%	44%	55%	82%	92%	81%	77%	59%	69%
SD	*22%*	*26%*	*31%*	*35%*	*32%*	*35%*	*28%*	*16%*	*27%*	*38%*	*34%*	*29%*
Management (%tage of Sole Holder)	97%	100%	96%	46%	29%	66%	88%	100%	94%	46%	79%	77%
Participated in an Organic AES (%)	47%	16%	20%	3%	20%	2%	61%	7%	23%	5%	28%	21%
Mixed to Specialist Enterprises (%)	1%	59%	40%	31%	17%	1%	42%	32%	0%	51%	31%	28%
Female Farmers (%)	24%	12%	17%	13%	13%	13%	0%	13%	29%	7%	15%	14%
Age of Main Decision Maker (Yrs)	42	49	52	59	47	54	48	47	50	56	59	51
SD	*10*	*13*	*12*	*14*	*11*	*13*	*10*	*9*	*11*	*10*	*11*	*11*
Farming Experience (Yrs)	25	32	31	37	32	29	32	26	27	29	38	31
SD	*10*	*15*	*13*	*18*	*13*	*13*	*10*	*11*	*13*	*15*	*15*	*13*

Table 2. Statements used within latent class analysis and descriptive statistics

		Mean	SD	Min	Max
Supply chain acceptance					
SCA1	The buyers of my products have little interest in the farming practices that I use*	3.21	1.32	1	5
SCA2	There are not many opportunities open to me in the market that would enable me to adopt more ecological farming practices*	2.86	1.11	1	5
SCA3	The requirements of those who buy my products restrict my ability to farm using more ecological farming practices*	3.51	1.19	1	5
	Social acceptance				
SA1	There is a lot of agreement amongst farmers I know that using ecological farming practices are a good thing to do	3.35	1.07	1	5
SA2	I have a strong sense of belonging to the farming community	4.08	0.92	1	5
SA3	Few farmers I know are using ecological practices*	2.81	1.19	1	5
	Farmer identity				
FI1	I see myself as a farmer who prioritises the environment	4.13	0.87	1	5
FI2	Understanding the ecology of the farm is what farming is about	4.04	0.89	1	5
FI3	Farming in a way that preserves the environment is part of who I am	4.22	0.80	1	5
	Farmer goals				
FG1	Knowing the practice is innovative	3.54	1.03	1	5
FG2	Taking steps to protect the environment only makes sense to the extent that they benefit agricultural production	2.98	1.27	1	5
FG3	It is important to adopt farming practices that provide environmental or social benefits	4.18	0.72	1	5
	Farmer knowledge and advice				
FKA1	It is important to continuously assess the environmental and social impact of my farm	4.01	0.82	1	5
FKA2	I have access to good advice and support on ecological farming practices	3.41	1.07	1	5
FKA3	I do not have the knowledge and skills to adopt more ecological farming practices*	3.40	1.16	1	5

* scales reversed to ensure statements are all positive

Table 3. Number of classes and the resultant identification of optimal classes

Model	LL	BIC	aBIC	cAIC	LR	Entropy
Model 1	-13669	27730	27539	27790	18585	-
Model 2	-12825	26496	26083	26626	16939	0.86
Model 3	-12448	26199	25564	26399	16354	0.90
Model 4	**-12101**	**25959**	**25102**	**26229**	**15788**	**0.91**
Model 5	-11940	26094	25015	26434	15532	0.90
Model 6	-11787	26245	24943	26655	15296	0.89

Table 4. Distribution of conditional probabilities and response per latent class

		Class 1					Class 2					Class 3					Class 4				
Supply Chain Acceptance	The buyers of my products have little interest in the farming practices that I use*	0.09	0.16	0.16	0.22	0.37	0.35	0.49	0.10	0.04	0.02	0.05	0.28	0.16	0.40	0.11	0.15	0.23	0.25	0.28	0.09
	There are not many opportunities open to me in the market that would enable me to adopt more ecological farming practices*	0.10	0.22	0.22	0.29	0.17	0.40	0.46	0.15	0.00	0.00	0.00	0.34	0.30	0.32	0.03	0.15	0.32	0.37	0.08	0.08
	The requirements of those who buy my products restrict my ability to farm using more ecological farming practices*	0.08	0.14	0.11	0.26	0.40	0.25	0.30	0.24	0.16	0.05	0.02	0.16	0.21	0.47	0.14	0.09	0.17	0.25	0.30	0.19
Social Acceptance	There is a lot of agreement amongst farmers I know that using ecological farming practices are a good thing to do	0.11	0.17	0.22	0.26	0.24	0.01	0.01	0.11	0.58	0.29	0.01	0.17	0.27	0.53	0.02	0.12	0.24	0.39	0.22	0.03
	I have a strong sense of belonging to the farming community	0.02	0.08	0.11	0.24	0.55	0.01	0.02	0.11	0.46	0.40	0.00	0.05	0.13	0.65	0.17	0.01	0.10	0.19	0.39	0.31
	Few farmers I know are using ecological practices*	0.17	0.25	0.19	0.23	0.16	0.39	0.50	0.10	0.02	0.00	0.01	0.31	0.24	0.39	0.04	0.17	0.40	0.27	0.09	0.07
Farmer Outlook	I see myself as a farmer who prioritises the environment	0.00	0.00	0.02	0.18	0.80	0.00	0.01	0.15	0.36	0.48	0.00	0.00	0.09	0.81	0.10	0.08	0.22	0.40	0.18	0.12
	Understanding the ecology of the farm is what farming is about	0.00	0.01	0.04	0.22	0.73	0.00	0.00	0.11	0.45	0.44	0.00	0.03	0.12	0.77	0.08	0.11	0.24	0.46	0.12	0.07
	Farming in a way that preserves the environment is part of who I am	0.01	0.00	0.00	0.12	0.87	0.01	0.00	0.08	0.40	0.51	0.00	0.00	0.07	0.78	0.15	0.03	0.10	0.50	0.32	0.05
Farmer Goals	Knowing the practice is innovative	0.04	0.09	0.23	0.36	0.28	0.01	0.01	0.03	0.26	0.69	0.02	0.14	0.22	0.55	0.06	0.08	0.10	0.55	0.22	0.05
	Taking steps to protect the environment only makes sense to the extent that they benefit agricultural production	0.32	0.28	0.13	0.13	0.14	0.00	0.02	0.18	0.33	0.47	0.02	0.45	0.16	0.34	0.04	0.04	0.15	0.25	0.44	0.12
	It is important to adopt farming practices that provide environmental or social benefits	0.00	0.00	0.02	0.30	0.67	0.00	0.00	0.02	0.15	0.83	0.00	0.02	0.08	0.80	0.10	0.00	0.02	0.53	0.40	0.05
Knowledge & Advisory Capacity	It is important to continuously assess the environmental and social impact of my farm	0.02	0.04	0.08	0.31	0.55	0.00	0.00	0.00	0.15	0.85	0.00	0.04	0.14	0.74	0.07	0.02	0.09	0.55	0.33	0.02
	I have access to good advice and support on ecological farming practices	0.04	0.06	0.16	0.44	0.30	0.15	0.37	0.23	0.16	0.10	0.01	0.19	0.25	0.50	0.03	0.18	0.23	0.33	0.20	0.05
	I do not have the knowledge and skills to adopt more ecological farming practices*	0.04	0.12	0.14	0.32	0.38	0.50	0.36	0.11	0.02	0.02	0.00	0.16	0.32	0.45	0.06	0.05	0.20	0.29	0.25	0.21

* scales are reversed to ensure statements are all positive

Table 5. LCA multinomial regression results, referenced against the enabled ecologists class, coefficients, odds ratios and significance

	Class 2:Constrained Ecologists				Class 3:Balanced Ecologists				Class 4: Unengaged			
	β	exp(β)	z	p	β	exp(β)	z	p	β	exp(β)	z	p
Participated in an Organic AES (%)	-1.101	0.332	-1.720	*	0.050	1.051	0.261		-0.596	0.551	-1.721	*
Participated in an AES (%)	-1.160	0.313	-2.629	**	-0.226	0.798	-1.236		-0.958	0.383	-3.362	**
Mixed Farming	-0.892	0.410	-1.854	*	0.291	1.337	1.505		-0.062	0.940	-0.203	
Gender	0.651	1.918	1.590		0.331	1.392	1.571		1.248	3.482	3.268	**
Household Size (Reference: 1-2)												
Household Members (2+)	-1.252	0.286	-2.433	**	-0.848	0.428	-3.329	**	-0.116	0.890	-0.314	
Farming Experience (Yrs)	-0.009	0.991	-0.806		-0.006	0.994	-0.971		-0.024	0.977	-2.666	**
Management Structure(Reference: Sole Owner)												
Partnership	-2.148	0.117	-1.762	*	0.047	1.048	0.192		-0.856	0.425	-2.059	*
Other	0.010	1.010	0.019		-0.281	0.755	-1.019		-1.283	0.277	-2.736	**
Owned to total land (%)	-0.372	0.689	-0.744		-0.457	0.633	-1.702	*	-0.295	0.745	-0.732	
Total Agricultural Area(ha)	0.001	1.001	1.717	*	0.000	1.000	-0.872		0.001	1.001	1.361	
Region (Reference: North Europe)												
Southern EU	0.775	2.170	1.324		-0.853	0.426	-3.162	**	-1.415	0.243	-2.833	**
Eastern EU	2.834	17.018	6.435	***	-0.448	0.639	-1.845	*	1.117	3.057	3.830	***

$^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$

Table 6. Adoption of Selected Ecological Practices by class

		Class1	Class2	Class 3	Class 4	Chi-sq.	Sig.
Integrated pest management principles (IPM)	Not Adopted	66%	70%	66%	85%	8.914	*
	Adopted	34%	30%	34%	15%		
Pest/disease resistant/tolerant varieties	Not Adopted	56%	65%	39%	70%	19.643	***
	Adopted	44%	35%	61%	30%		
Planting of nitrogen-fixing crops	Not Adopted	73%	78%	88%	100%	24.059	***
	Adopted	27%	22%	12%	0%		
Planting of catch crops	Not Adopted	91%	89%	89%	100%	7.333	-
	Adopted	9%	11%	11%	0%		
Planting of cover crops	Not Adopted	83%	86%	94%	100%	15.847	**
	Adopted	17%	14%	6%	0%		
Conservation tillage	Not Adopted	56%	71%	73%	74%	13.646	**
	Adopted	44%	29%	27%	26%		
No tillage	Not Adopted	64%	83%	90%	100%	48.414	***
	Adopted	36%	17%	10%	0%		

$^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$

Figure 1. Path diagram of latent class model of Ecological types with covariates