

Article

Exploring the Relationship between Farmers' Innovativeness and Their Values and Aims

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Abstract: To meet global demands towards food security, safety as well as sustainable agriculture and food systems innovative approaches are inevitable. Despite the growing body of literature in both innovation research and in values and aims, what has been explored to a lesser extent is the bridging link between these areas. This study represents a first step in addressing this relationship. Policy- and decision-makers foster sustainable innovation in agriculture, since on-farm innovation and innovation adoption have attracted their attention as a means of enhancing competitiveness as well as socially and environmentally benign farming also benefiting rural areas. By using a negative binomial model we explore the relationship between farmers' innovativeness and those values and aims which guide farmers' farm- management decisions as well as other farm/farmer characteristics. Based on a sample of 174 Austrian farmers agricultural education is found to be an essential driver of innovativeness. Regarding the different values we find that self-direction and hedonistic values, in contrast to achievement and economic, are associated with more innovative capabilities. In conclusion, we see a need to foster self-direction and hedonistic narratives in policy and extension service, together with reducing the focus on an economic angle to promote farmers' innovation capabilities.

Keywords: farmers' innovativeness; values; aims; sustainable intensification; innovation policy; competitiveness; negative binomial model

1. Introduction

To meet global demands towards food security, safety as well as sustainable agriculture and food systems innovative approaches are inevitable. Although divergent strategies for a multifunctional and multifaceted agriculture exist, there seems to be consensus that various types of innovation are needed to ease this sustainable transformation [1–3]. The predominant model for the reasoning of innovation seems to be that it causes increased productivity and competitive advantage—resulting in higher revenues and allowing for more innovation in a quasi perpetuum cycle. Innovations are assumed to cause enhancements in productivity and competitiveness, making further innovations even more profitable. This relationship is also known in the literature as the “Marx-Schumpeterian model” [4–6]. Consequently, an imperative of innovation can also be observed in the agricultural

sector. Since farmers operate in a highly competitive and rapidly changing environment [7] and are also striving for higher revenue, it is not surprising that innovation is one of the best means of achieving such competitive advantage and revenue growth [2,3,8]. Arising from this circular logic, in combination with increasingly relevant sustainability principles, is the handy narrative: If you want more revenue—and you definitely should—you have to be innovative and have to strive for sustainable efficiency [9]. Agricultural innovation is considered an important aspect in farming throughout the world [8,10]. For the European Union, innovation is in fact the “only answer” to urgent questions like energy supply, demographic change and the creation of new jobs [11]. However, agri-food innovations are also seen as being closely connected to what is called “the triple burden of malnutrition” and thus require a controlled and steered process [12]. Ever since the seminal paper by Zvi Griliches in 1957 on innovation diffusion of hybrid corn in the US, identifying the most prolific drivers of innovation on farms is of utmost importance for policy and extension [13,14].

To increase the innovativeness of farmers, investment support and meliorated access to loans are regarded as an effective policy instrument [15]. This recommendation is also supported by the fact that farmers often face high costs and risks when innovating and experimenting [5]. This strategy, therefore, mainly addresses the achievement and stability values and aims of farmers.

In addition to investment support, raising the educational level, as well as training and learning from best practice examples, are identified as crucial for the innovation activities of farmers [15–18]. Education as a key component in enhancing innovativeness is also identified as invaluable for small businesses other than agriculture by investigating a binary outcome variable [19]. Moreover, investigation of other personal traits such as attitudes and behavioural control shows how important these aspects are in actively following up-to-date practices [16,20]. Although an ever-growing interest in increasing farmers’ innovativeness can be observed, it should not be forgotten that even small-holder farmers have been innovating and experimenting and creating knowledge at least on a small scale since the Neolithic Revolution [21]. This knowledge is today made accessible via participatory research and the implementation of the EIP-Agri [22].

Almost equally important to farmers’ individual innovativeness are the surrounding neighbourhood and peer groups, as well as the more comprehensive concept of an Agricultural Innovation System (AIS) [23]. This system supports a modernisation of farms and goes well beyond the linear model of innovation [24–26]. Based on a meta-analysis of innovation co-production studies, Klerkx and Nettle [27] argue for an increase in stakeholder participation and facilitation of this process from policy-makers.

Although many studies address farmers’ innovativeness from diverse perspectives, one of the most important incentives for raising farmers’ innovation activities seems to be a more-or-less explicitly stated economic consideration. In this article, however, we argue that “it is not from the striving of the farmers for higher revenues that we expect our newly introduced and considerably changed products, but from their regard to their self-realisation and well-being”.

Neither the body of economic literature nor that of social-psychology covers the bridge between values and innovation activities very extensively (for instance: [28]). A comprehensive link between these two strands of theory is still missing to a large extent, although the Schwartz concept of “Basic Human Values” offers a second level of polar dimensions which links several basic human values to a more change-promoting personality [29]. Nevertheless, the personal traits of entrepreneurs are found to be significant in influencing innovativeness [30].

Our article will therefore link the innovation activities of farmers to their values and aims. The next section will present and discuss the literature and theoretical backdrop of innovation measurement and basic human values. The Methodology section will subsequently describe our approach and dataset. In particular, we will explain the composition of the data and the empirical model. By means of a negative binomial regression model, we will explain the relationship between farmers’ innovativeness and their values and aims, while simultaneously controlling for other factors which are assumed to influence innovation activities. The Results section will highlight the findings which we base

our conclusions upon. In the section on Discussion, we will compare our modelling results with others studies and critically discuss the study. We finish our article with concluding remarks offering suggestions for policy and extension as well as pointers for farmers themselves and future research.

2. Theoretical Background

According to Smith [31], innovation measurement is seen as a task which cannot be sufficiently done with enough accuracy. In fact, Moldaschl [32] goes even further in arguing that there is not, and there most probably will never be, a satisfactory theory of innovation. However, the tradition in innovation measurement in the manufacturing sector—although not well established in agriculture then—dates back to the 1970s. It was then that databases mainly of product innovations were used to investigate and analyse the characteristics of innovators and early adopters. Regression models were applied, using the percentage of innovations by a firm in a sector as dependent variable and thus output measure [6,33]. Consequently, measuring innovation activities at sector level or national level is mostly done by aggregating the data of single firms to an index or a value. This allows for a comparison of innovation activities and their development over time and across countries. An instrument appropriate and designed to offer such comparison subsequent to data collection is the so-called “Community Innovation Survey” (CIS) [34]. The CIS only compares innovations based on a dichotomous Yes/No classification, and not beyond, by means of a more nuanced ranking of innovators. However, farmers seldom take part in this survey since, amongst other reasons, only holdings with more than fifteen employees are in the sample—seldom the case for farms.

Other indicators most often used to identify innovative enterprises are the number of patents or processes (output), R&D expenditures or R&D workforce (input) and turnover resulting from newly introduced products [31,35,36]. For instance, Edison et al. [35] applied an exhaustive mixed-methods approach and elaborated a conceptual analysis which yielded an innovation measurement model. In their analysis of small-food enterprises, Tessa Avermaete and her colleagues [8] ran several hypotheses tests on a sample of 55 food enterprises for drivers of innovation. They found that nearly 90% introduced at least one of five possible innovation types (i.e., indicators of innovation) over a period of five years. Another way to measure innovation and innovation capabilities was suggested by Rejeb et al. [37], who evaluated processes in the form of multi-criteria models. At farm level, however, measuring innovation activities is more complicated, since patents and R&D expenditures cannot be obtained and records on processes are sparse. Moreover, the innovation capacity of small enterprises is rather limited, since time and resources for R&D are not easily available. This holds true for agriculture [8,38]. Compared to other sectors, it is, at least in Austria, mainly characterised by small- and medium-sized holdings which are run as family farms. According to Pavitt [33], agriculture can be regarded as a supplier-dominated sector which owes its innovations and its technical progress to companies supplying these advancements; it is thus reasonable that research focuses in particular on the diffusion process and adoption, rather than on innovation or invention itself [13].

Nevertheless, it is important to find ways which also allow for measurements of innovation as well as innovativeness at farm level. This is particularly relevant if policy evaluation of the numerous incentives given to increase innovations and competitiveness is to offer reliable results. Multiple approaches to measuring innovativeness as a variable, ranging from binary/multinomial, to ordered or numeric measurements, are used in the literature. In constructing different key figures to make innovation activities more tangible, the following studies offer valuable solutions by facilitating the goal of measuring and analysing innovation activities.

Diederer et al. [39] analyse the adoption of innovation at farm level with a sample of Dutch farms. They distinguish between frontrunners (i.e., innovators and early adopters) and laggards (late and non-adopters) respectively, based on the point on the diffusion curve for the stated innovation given by the surveyed farmers and subsequently evaluated by a team of experts. This approach could be seen as the most basic, since it only asks whether or not an innovation is implemented and merely adds limited qualitative information via the point on the diffusion curve. Application of this procedure

delivers only Yes/No information for each farmer, not the number of innovations over a given time period and only limited additional qualitative information. This indicator has subsequently been used as a dependent variable in a nested logit model to account for different reasons in farmers' innovation behaviour. A more complex way to gain a measurement of farmers' innovativeness is to investigate the implementation of a given set or list of innovations [15,40,41]. All three researcher-groups employed predefined innovations relevant for a specific kind of farm holding (e.g., milking robot for dairy farms). Having implemented almost all innovations would lead to a classification of those farmers as innovators. While L  pple et al. [15] and Karafillis and Papanagiotou [40] only ask about whether or not the innovations have been implemented, Nossal and Lim [41], who also offer a more elaborated set of innovations, differentiate the degree of implementation with "not at all or very little", "to some extent" and "to a great extent". The innovation measure is subsequently used in econometric models and acts either as a dependent [15,41] or independent variable [40]. The most extensive method of obtaining a measurement of innovativeness is offered by Ariza et al. [42], who do not limit the surveyed farmers in reporting their implemented innovations to a predefined set of innovations. Subsequently, the research team associates each innovation mentioned by the farmers to a certain innovation type (i.e., product, process, marketing, organisation) and, based on expert evaluations, classifies them into major, intermediate and minor innovative. The innovation index by Ariza et al. [42] allows a linear regression, since the dependent variable is a non-negative index value between 0 and 100. Innovativeness as a function of the number, quality or depth of implemented innovations is augmented by L  pple et al. [15], who also include the acquisition of knowledge and an indicator of continuous innovations as important determinants in their index of innovativeness.

The value concept is discussed at length in sociology (for instance by Durkheim and Weber, cited by Schwartz [29]) and arguably has a great influence on almost all social behaviour from consumption to leisure activities. The lack of agreement upon both the measurement of values and, more importantly, their definition and concept has been widely discussed in literature. Moreover, different constructs like attitudes, norms and beliefs are often used interchangeably to explain human (social) behaviour [16,20]. Values, however, can be seen as the most fundamental personal trait of all these concepts. Nevertheless, confusion between concepts and explanations still exists. Several different value-systems and surveys can be found in the scientific literature [43,44]. McDonald and Gandz [43], for instance, also offer values which can be associated with enhanced innovation behaviour like experimentation and creativity. Schwartz [29] and several other authors, meanwhile, base their analysis on Schwartz' theory and take the change-promoting combination of several values for granted. In Figure 1 the circle of Basic Human Values and their relation "of conflict and congruity [...] along two bipolar dimensions" [29] is depicted.

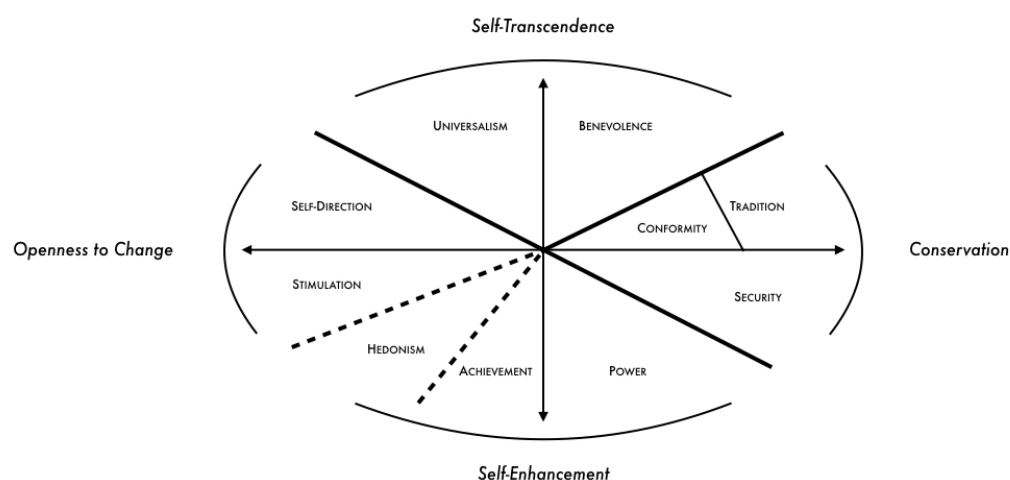


Figure 1. Circle of Basic Human Values and the corresponding dimensions (own representation based on Schwartz [29])

Therefore, to derive from values over beliefs, attitudes and behaviour, theoretically one has to link these concepts. Studies so far have emphasised the causal relationship between human values (like universalism and benevolence) and certain behaviours, such as sustainable consumption [45] or buying organic food [46]. In addition, Braitto et al. [47] link human values with the concept of Human Nature Relationship (HNR) and find significant arguments for specific values being more pronounced in different types of HNR. Personal values are also found to be associated with certain motivations (e.g., benevolence and altruism) in contributors to open-source programmes by Oreg and Nov [48], while the link between an innovative organisational culture and an expressed self-direction inclination of the CEO is supported by Berson and his colleagues [49].

Although Grunert and Juhl [46] argue that “values are [...] criteria used to select and justify actions and to evaluate people, including the self, and events”, while van der Werff et al. [50] state that “values reflect what people find important in their lives”, value concepts are sparsely used in explaining innovation activities in companies. Nevertheless, according to the definitions given above, it would be reasonable to assume that an entrepreneur’s value-system which favours openness to change is associated with a higher degree of innovativeness and more innovations. To the best of our knowledge, the only empirical study trying specifically to link a set of values to innovativeness is done by Katrinli et al. [28]. They do not find evidence that adhering to achievement or traditional values influences entrepreneurs’ innovativeness positively, while favouring security values and rejection of power values correlates positively with innovativeness. Following the second premise and the logic behind Romer’s [51] theory on endogenous technological change, innovations result “from the attempts [...] to earn a profit”. One would expect that particularly the achievement value should be articulated by the most innovative entrepreneurs. In fact, Berson et al. [49] conclude that an organisational culture which facilitates innovation is linked to and can lead to sales growth. In the agricultural literature, however, there is ample evidence of how psychological traits influence such behaviour as innovation, environmentally sound practices or risk-taking. Even in this respect the differentiation between attitudes and objectives is not always clear cut (see for instance: [52]). According to Willock and her colleagues [52], it is not unusual for agricultural economists to conclude that innovative behaviour is highly associated with an ascending profitability. Hence, there seem to be several concepts of values, as well as other constructs like beliefs and attitudes, and hypotheses and assumptions—all fostering innovation. According to the extension of the core values [53], a grouping of the ten basic value types can be done. These four clusters, which are more exhaustive and on a higher level of abstraction, span the axes from “Openness to Change” to “Conservation” as well as from “Self-Transcendence” to “Self-Enhancement” (see Figure 1). Moreover, Rice [54] finds that perceived creativity is more pronounced in employees who favour self-direction, while Baron and Tang [55] find that creativity has a positive influence on innovation. From this idea, a more obvious focus on self-direction, stimulation and hedonism should - above all other values—lead to a broader innovation spectrum at farm level.

3. Methodology

The methodology section will describe the study design as well as the data used and will explain the theoretical deliberations on the empirical model, as consequences of a long tradition in studies of both innovation and human values and aims. We use the theoretical underpinning of Schwartz [53] for the set of values and aims which were ranked by the participants.

The data were collected via an assisted online survey among all voluntary bookkeeping farmers in Austria in 2016. The data basis provides a representative sample of the farming population in Austria and contains accountancy data as well as structural farm data which is collected in a harmonised manner. These data are mainly used to show the development of the income of different types of farms, based on farm type, size, location, etc., and are published in a yearly report by the Austrian Ministry of Sustainability and Tourism. Of the 2166 farmers in the dataset [56], 174 answered the question on values and aims (Table 1). This sample size offers sufficient power of statistical test but although the

sample is a subsample of a representative sample of Austrian farms it is possible that it is skewed since it cannot be regarded as a random sample.

Table 1. Descriptive statistics of the dataset $n = 174$.

Values and Aims	Median	Mean	Definition
Security and Resilience	8	6.82	numeric
Achievement and Economic Success	7	6.74	numeric
Hedonism and Health	7	6.53	numeric
Self-direction	6	5.76	numeric
Production and Nature	5	5.00	numeric
Universalism and Biodiversity	4	4.36	numeric
Benevolence and Cultural Landscape	4	4.1	numeric
Common Good and Social Cohesion	3	3.57	numeric
Tradition	1	2.15	numeric
Variable	%	% Bookkeeping farms ($n = 2.166$)	Definition
Higher Agricultural Education	63	-	=1 if farmer has higher agricultural education
Full-time Farmer	72	60	=1 if farmer is full-time farmer
Male	82	-	=1 if farmer is male
Standard Output 1 [8.000–30.000)	19	18	=1 standard output falls in class 1
Standard Output 2 [30.000–100.000)	57	53	=1 standard output falls in class 1
Standard Output 3 [100.000–350.000)	24	23	=1 standard output falls in class 1
Fieldcrop	16	15	=1 if farm is classified as field crop farm
Permanent Crop	3	8	=1 if farm is classified as permanent crop farm
Feed	46	47	=1 if farm is classified as feed farm
Fattening	10	8	=1 if farm is classified as fattening farm
Mixed	14	14	=1 if farm is classified as mixed farm
Forestry	10	8	=1 if farm is classified as forestry farm
Age	avrg. 48.2	range: 18–69	numeric

The respondents were asked to rank nine values of their farm management, according to their perceived degree of importance. The instruction to the farmer was: “Please evaluate how important the following points are to you for the management of your farm and rank the goals according to their importance”, following Rokeach’s value survey [44]. These nine values or aims were formulated as single items suitable for agriculture which referred to the values depicted by Schwartz’ circle of Basic Human Values (see Figure 1). To keep the sorting process manageable for the respondents, the values were reformulated for a better fit in the agricultural sector. Additionally, more emphasis was placed upon making sustainability aspects such as social cohesion and environmental considerations explicit. Various other farm and farmer characteristics are assumed to have an impact on farmers’ innovation activities and their innovation spectrum, but these were not included due to a lack of data availability. For instance, the spatial dependence of innovation activities is pointed out in several studies [20,57,58]. As outlined above, neither the general innovation literature nor studies on agricultural innovation offer a consistent way to measure innovativeness. We use this term in a similar way to the definition given by Hirschman [59]—the propensity to adopt something novel. In order to measure the innovation spectrum of farmers, the number of different innovation types was taken as a yardstick in our study. Farmers were asked to indicate which types of innovations were implemented from 2011 to 2015. The questionnaire offered twelve different innovation types in total, ranging from innovative changes in the farm’s organisation to product innovations. Based on the OECD [60] (p. 46) definition we asked for “the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations”. With regard to these innovation types, it was sufficient if the innovation was “new to the farm”, hence, not an invention which ought to be “new to the world”.

With the dataset described above, we estimate an econometric model in order to empirically investigate the relationship between farmers' innovativeness and those values and aims which guide farmers' farm- management decisions as well as other farm/farmer characteristics. Since the variable of interest y (the number of innovation types implemented by a farmer in a given time period) is a count variable, a Poisson model is the first choice [61]. It links the linear predictor

$$\eta(\mathbf{x}) := \beta_0 + \sum_{j=1}^p \beta_j x_j$$

to the mean μ of the response y via a so-called link function $g(\cdot)$, typically the (natural) logarithm

$$g(\mu) = \log(\mu) = \eta(\mathbf{x}) = \beta_0 + \sum_{j=1}^p \beta_j x_j.$$

While the latter equation describes the systematic part of the model, its random component is a Poisson distribution with $y \sim \text{Pois}(\mu)$. In a slight modification the Poisson distribution is often replaced by the negative binomial distribution to account for overdispersion [62–65].

In the present situation values and aims as well as the farm characteristics listed in Table 1 are used as (numeric or categorical) explanatory variables x_j , in the above equation collected in a p -vector $\mathbf{x}$, whereas the number of implemented innovation types acts as response y . The model outcome are estimates of the intercept $\hat{\beta}_0$ and the regression coefficients $\hat{\beta}_j$. When exponentiated, $\exp(\hat{\beta}_j)$, these values can be interpreted as multiplicative effects on the response when the corresponding regressor x_j increases by a single unit (in case of a numerical predictor) or when switching from the reference category to the current one (categorical predictor).

In most cases, not all p explanatory variables x_j will have a significant effect on the response y and should not be considered in a final model. Therefore, the Akaike information criterion (AIC) [66] is used for model selection [67]. Several computational steps were performed in R [67–69].

4. Results

Descriptive results of the dataset and the parameters chosen for the empirical model are depicted in Table 1. Based on the median, the most important aim for the 174 farmers in the dataset is Security and Resilience (i.e., preserving the farm for and passing it on to subsequent generations), followed by Achievement and Economic Success and Hedonistic and Health. Values on the social and environmental dimension are of medium importance, while a traditional approach in farming and farm management is not regarded as a crucial value for the farmers in the dataset and is thus ranked bottom. The other parameters are given in the lower part of Table 1 and show that the sample bears some resemblance to the whole sample of bookkeeping farmers in the year 2015. Besides the values and aims, only age is integrated as a numerical variable to the model.

The results from the negative binomial regression model (Table 2) show first of all that many of the values and aims under investigation, as well as other variables from the full model, are not included in the final model (column 2, as selected by the AIC criterion). In building the model we went from a literature-guided model (column 1 in Table 2) to a model that includes the values and aims (Full Model). The marginal effects of the final model parameters can be calculated as depicted in the methods section via exponentiation ($\exp(\hat{\beta}_j)$) and are summarised in Table 3.

Having a value of 1.57 ($\exp(\hat{\beta}_j = 0.45)$), *Higher Agricultural Education* shows that farmers who have received a higher standard of agricultural education are more likely to show a wide innovation spectrum (i.e., having implemented several innovation types during the years 2011–2015).

Table 2. Estimation of the Negative Binomial Model.

	1	Final Model	3
Higher Agricultural Education	0.434 *** (0.134)	0.450 *** (0.129)	0.458 *** (0.132)
Full Time Farmer	−0.298 ** (0.151)	−0.390 *** (0.138)	−0.353 ** (0.144)
Male	−0.046 (0.175)		−0.174 (0.175)
Age	−0.007 (0.007)	−0.010 (0.007)	−0.012 * (0.007)
Age ²	0.001 * (0.0005)	0.001 * (0.0004)	0.001 ** (0.0005)
Standard Output class 2	0.404 ** (0.185)	0.488 *** (0.177)	0.523 *** (0.181)
Standard Output class 3	0.542 ** (0.226)	0.705 *** (0.210)	0.767 *** (0.227)
Farm Type Field Crop	0.015 (0.208)		−0.081 (0.198)
Farm Type Permanent Crop	−0.061 (0.337)		−0.030 (0.321)
Farm Type Feed	−0.307 * (0.184)	−0.319 *** (0.117)	−0.464 *** (0.176)
Farm Type Fattening	−0.013 (0.237)		−0.157 (0.224)
Farm Type Forestry	−0.268 (0.254)		−0.285 (0.240)
Achievement and Economic Success		−0.082 *** (0.028)	−0.075 * (0.039)
Hedonism and Health		0.057 ** (0.028)	0.075 ** (0.038)
Self-direction and Stimulation		0.043 * (0.024)	0.052 (0.035)
Security and Resilience			−0.003 (0.035)
Tradition			−0.007 (0.038)
Benevolence and Cultural Landscape			0.032 (0.041)
Universalism and Biodiversity			0.011 (0.037)
Production Factors and Nature			0.012 (0.041)
Constant	0.853 *** (0.241)	0.685 ** (0.339)	0.440 (1.156)
Log Likelihood	−380.797	−374.104	−371.977
Akaike Inf. Crit.	787.594	770.208	785.954

Notes : * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$, Standard error in parentheses.

Based on our model results, full-time farmers are less likely to implement several innovation types. Thus, working off-farm raises the chances of implementing more innovation types when controlling for the other variables (multiplicative effect for full time farmers of 0.68 ($\exp(-0.39)$)). However, we also find a positive relationship between farm size (measured as standard output) and the number of innovation types. Via the integration of a squared term of age, we find evidence that the relationship between innovativeness and age is U-shaped, meaning that younger as well as older farmers have a greater chance of being among the more innovative farmers.

Our model also shows that, compared to all the other farm types in our sample, those farms which are producing feed (to a large extent, dairy farms) have implemented a narrower spectrum of innovations than the other farm types (see Table 2).

Table 3. Marginal Effects of Final Model.

	Estimate	2.5%	97.5%
Intercept	1.98	1.02	3.83
Higher Agricultural Education	1.57	1.22	2.03
Full Time Farmer	0.68	0.51	0.89
Age	0.99	0.98	1.00
Age ²	1.00	1.00	1.00
Standard Output class 2	1.63	1.15	2.31
Standard Output class 3	2.02	1.35	3.07
Farm Type Feed	0.73	0.58	0.91
Achievement and Economic Success	0.92	0.87	0.97
Hedonism and Health	1.06	1.00	1.12
Self-direction and Stimulation	1.04	1.00	1.09

From the Basic Human Value section which we measured via our single-item ranking (as described in Methodology), Hedonism and Well-being as well as Self-direction and Stimulation are associated with a broader spectrum of innovativeness. Moreover, and perhaps more importantly, favouring the values and aims Achievement and Economic Success is actually associated with a lower number of implemented innovation types in our model. All other values were discarded in the final model based on the aim of achieving a lower AIC as compared to the full model. Taking the values into consideration, the results of our model show that prioritising the value of Self-direction and Stimulation has a positive influence on the innovativeness of farmers. Additionally, hedonistic values, in form of favouring Well-being, also raise the probability of farmers being among the more innovative ones. We could not find evidence for or against the influence of environmental as well as stability values on the innovativeness of farmers. Furthermore, the value “tradition” is not found to influence the spectrum of innovativeness in our model.

The gender of the farmer was also not included based on the AIC in the final model.

5. Discussion

We analysed a unique data-set on innovation activities over the period 2011–2015 of 174 Austrian farmers. Our main interest was to explore the relationship between certain values focused on sustainability and farmers’ innovation spectrum, as measured via implemented types of innovation. Once again, we can point to the main result being that financial incentives (i.e., the economic dimension), although very important, are not the be-all and end-all for those farmers who showed a broad spectrum in their innovation activities. More importantly, it is highly doubtful that there is a straightforward relationship between the most radically innovative firms and their economic success [70].

Our study showed that, apart from a higher agricultural education level and farm size, which are both found to enhance innovativeness by other authors [15,17,19,41,71], in particular the values and aims of self-realisation and hedonism are associated with the uptake of innovations by farmers. This is in line with the Schwartz theory on Basic Human Values - especially the bipolar dimension of these values (see Figure 1; [29]). According to this meta-level-grouping of values, people favouring self-realisation and hedonistic values are more open to change. It is this very value- and aim- system of farmers which seems to be related to a higher level of innovativeness in our model.

From the set of value indicators we compared in our study, the aforementioned values raise the innovativeness of farmers based on our analysis. Hence, decision- and policy-makers intending to make farmers more innovative should also pay attention to the dimension of self-realisation in their communication and educational efforts. Although working mainly with the incentive of monetary gains and stability might work, those who forego some of these benefits and try to fully realise their individual and farm potential come up with more innovations. In addition, aiming to enhance wellbeing (i.e., hedonism) leads to more implemented innovation types per farm as can be seen in the final model (see: Table 2). Valuing tradition is not found to influence the innovativeness in our model. This is against the assumptions made by Schwartz [29], who places traditional and security values as conservative, opposite of change-promoting stances, which would expect a negative influence on innovation activities for farmers prioritising traditional values. However, as can be seen from Table 1, tradition is overall ranked as lowest important for the sampled farmers.

When testing for other size variables like milk quota or size of utilisable agricultural area, other authors also find a similar relationship with respect to innovative activities [14,15]. However, our model also suggests off-farm employment to be positively associated with the number of implemented innovation types. This is not surprising in that an occupation outside the farm might be a proxy for sources of information or ideas from a different context which are relevant for solving farm problems through innovations. In the literature we find opposing evidence regarding the relationship between off-farm employment and innovativeness. Läßle et al. [15] find a negative influence of off-farm work on innovation; so do Sauer and Zilberman [14], who also find this barrier of innovation

implementation based on the off-farm income. In contrast, Lin [72] does not find any relationship. Our definition of innovation spectrum allows for more innovation types, including organisational and marketing innovations, than in the three aforementioned studies, where innovation activities are pre-defined and mainly focused on the adoption of production- or process technologies. This finding hints at the innovative potential of part-time farmers, going beyond the mere adoption of production technologies. This means that, while we find a positive effect of off-farm employment, we also observe a separate size-effect.

With regard to the type of holding, in particular Läßle et al. [15] find higher innovativeness among dairy farms. In fact, our innovativeness indicator (as a measurement of implemented types of innovations) is chosen in order not to prevent specific farm types or sizes receiving a high score (see Section 3 for explanation). Specialised dairy farms mainly focus on improving their milk production and might not have to make changes in their marketing endeavours when a milking robot is bought. In line with our results on full-time farmers, it is possible to say that specialised farms tend to innovate less often but if and when they do, it is perhaps more intense from the perspective of innovation degree, which was not taken into consideration in our model.

Our model shows that the age of the farmer is connected to their innovation activities which supports the finding of several other authors [15,41]. Although there is ample evidence of an effect of gender on innovation behaviour in the literature [73,74] we could not find an effect of the gender of the farmer in our final model. Especially in our model, where we allow for a high variety of innovation types to contribute to a measure of innovativeness, this is even less surprising than in studies where mainly technological innovations are under investigation. If anything, we see in the initial model (column 1 in Table 2) that female farmers seem to implement more different innovation types compared to male farmers.

From our data, however, we cannot conclude that having implemented more innovation types will subsequently result in higher revenues or competitiveness since we lack this information in our dataset. It is even doubtful that attaining more innovation types increases the subjective perception of quality of life. This might be explained by the fact that farmers who are constantly trying to be innovative and to find solutions to problems might also be more inclined to identify such problems in the first place. It is perfectly possible that these farmers are, in a way, permanently surrounded by problems and challenges. When interpreting the negative effect of achievement and economic values, we do of course not argue that higher profits are irrelevant to farmers; nor do we say that other values, such as security in the form of a stable and resilient farm which can be taken up by the next generation, are to be neglected. In fact, from our study we can conclude that the most important values in farming seem to be precisely that form of security and also—achievement. However, this holds true for all farmers—the innovative as well as the not-so-innovative ones (see Table 1). The values which distinguish those who can be regarded as farmers implementing a broad spectrum of innovations from the rest are an articulated focus on self-realisation and hedonism, with a discarding of purely economic achievement.

While the results show several nexuses related to the number of innovation types which were implemented by farmers between 2011 and 2015, there are some limitations to the dataset. First of all, unlike previous analyses, our data do not include information on other economic activity such as specific shares of income, gross margin, profit etc. of each farmer and farm household. Secondly, innovation intensity or degree is not taken into consideration in our analysis. This is mainly due to the possibility of a better comparison between different types of farms and farmers. On the other hand, our dataset does comprise information on various types and sizes of farms and is thus not limited to (presumably more innovative) farm-types and large holdings. Nevertheless, evaluating aims only in an isolated manner and not in a continuum of motivational backdrops may not represent a holistic approach and might have several shortcomings. Single aims are of much interest but taking the theory of basic human values holistically, they are not reflected as single values in one person but only in the trade-off and conflict of values which a certain behaviour results in. Our model, although based

on several values, offers only three significant values in its final version. Hence, it is not certain how the ranking and importance of other values might interfere with this. A second point is the measurement and evaluation of innovativeness. As described in detail, this endeavour is not trivial. The idea is always to identify the most and the least innovative farmers. Given the ample debate on what classifies as an innovation, it is even more delicate to label one farmer as highly innovative. While it is straightforward to identify the non-innovators (given the definition of what counts as an innovation), the measuring of the innovativeness of the remaining farmers is not. We decided on a rather conservative approach which did not limit the study to a specific type of farm and farmer; thus, we used innovation types and not the concrete number and degree of single innovations.

6. Conclusions

The interpretation of our final model has far-reaching consequences. Promoting the innovative capabilities of farmers is regarded as vital to the farming sector as well as for rural areas. Hence, increasing the economic inclination of farmers is not the cardinal principle for raising innovativeness but, more importantly, it is in order to foster the self-direction (i.e., autonomy) of farmers and their stance towards hedonism and well-being. Policy-makers, agricultural stakeholders, upstream and downstream sectors and extension services should enhance the value and aims in the area of self-direction and hedonism, while the current focus on competitiveness and achievement should be reduced. For governance strategies, this offers ample room for manoeuvre and improvement in addition to the instruments which are already in place. Stimulation of networks, investment support, best-practice examples via competitions and innovation fairs, extension etc. definitely do their job. Indeed, the literature offers sufficient evidence for the utility of these tools [75]. However, it is highly likely that when farmers are more self-determined and act autonomously, they will also promote and pursue a broader innovation spectrum on their farm. This in turn can have a positive effect upon society.

Although our study only offers a first step in linking sustainability values and innovation activities, the link between certain values and aims and the spectrum of innovations on farms offers a means of further investigation into this relationship. Future research on farmers' innovation activities must focus on two major aspects. First of all, it is necessary to find a comprehensive way to measure the innovation activities of farmers, if possible on a metric scale. Secondly, a more differentiated analysis of the relationship between values and aims and innovation activities is needed. Other disciplines have already investigated values and aims as prerequisites for specific behaviour and also possible mechanisms to incentivise people for intended behaviour. While attitudes and beliefs are certainly important, a fundamental understanding of the value system of the most and least innovative entrepreneurs will surely offer crucial insights. Additionally, a comparison of economic performance indicators among those farmers with a narrower and a broader innovation spectrum would be of great interest. As already mentioned, what leads to a certain type of behaviour is not a single aim or value but the balancing of a diverse set of conflicting values and thus areas of sustainable farming. Our claim is that giving farmers more autonomy and offering methods to strengthen their self-realisation and hedonistic values will release an innovation power which at present lays fellow. The political narrative must not, therefore, forget about these trade-offs and should foster additional values which seem promising in tackling future societal and global challenges regarding sustainable agriculture and food systems.

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