FARMERS' ENVIRONMENTAL AWARENESS:

CONSTRUCT DEVELOPMENT, MEASUREMENT, AND USE

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Abstract

This paper aims to contribute to the empirical measurement of farmers' environmental awareness, and improve the understanding of the role of environmental awareness in farmers' adoption of cleaner agricultural practices. We provide a theoretical and methodological framework for measuring environmental awareness as a multi-dimensional concept. The data obtained from a survey of 382 farmers in northern Serbia are used as an empirical basis to test the developed latent environmental awareness construct. This construct includes several domains: environmental knowledge, biospheric concern, connectedness to nature, environmental attitudes, and environmental behavior. The results show that environmental knowledge contributes the most to explaining the environmental awareness construct (factor loading=0.83), whereas biospheric concern contributes the least (factor loading=0.23). Regarding agricultural practices, environmental awareness is higher among farmers who use biological pest control (+23%), mulching (+17%), and green manure (+9%). Furthermore, our results uncover the role of farmers' environmental awareness in the adoption of more sustainable agricultural practices. These results document the operational validity of the construct and its potential use in research activities and management programs geared toward promoting environmentally friendly food production.

Keywords: environmental awareness, measurement, scale, farmers, environmentally friendly agricultural practices

1. Introduction

Agriculture is a pivotal element in the so-called agroecosystem. Agricultural land constitutes approximately 40% of the total land area on Earth (Tilman et al., 2002; Andrén and Kätterer, 2008). Many scholars argue that modern agriculture, rooted in input-intensive farming and specialization, has severe detrimental effects on the state of the environment, resulting in the loss of ecosystem services and functioning (Wilson and Tisdell, 2001). Indeed, agricultural activity can often have serious environmental consequences such as land degradation, contamination of flora and fauna with pesticides and chemicals, deforestation, water pollution, and loss of functional biodiversity (Caracciolo and Lombardi, 2012).

To reduce the negative impact of agriculture on the environment, current agricultural practices need to be changed (Wezel et al., 2014). Although various environmentally friendly agricultural practices exist (such as conservation tillage, planting cover crops, and biological pest control, to name a few), they are not widespread enough for an ecological intensification of agricultural systems (Lamine, 2011; Oyetunde Usman et al., 2020). This is because a wide variety of barriers hinder their extensive adoption (Rodriguez et al., 2009; Luo et al., 2016; Aregay et al., 2018).

Therefore, there is a need to study why many farmers prefer current farming practices even though they are unsustainable, and what factors limit the use of sustainable practices. The literature suggests the existence of numerous such factors (Baumgart-Getz et al., 2012; Ndiritu et al., 2014; Muriithi et al., 2018; Oyetunde Usman et al., 2020). Until recently, studies mainly focused on the role of the socio-demographic characteristics of the farmers and structural characteristics of farms (Mozzato et al., 2018). Recently, however, studies have identified a much larger number of factors, including those in several psychological/behavioral dimensions, that play a significant role in farmers' decisions on

which practices to adopt (Migliore et al., 2014). These include various elements broadly attributable to environmental awareness (EA), which is the focus of this study.

Despite the widespread use of the EA concept in academia (Reimer et al., 2012), EA has not been uniquely defined (Cynk, 2017). Moreover, while there are various opinions as to what comprises EA (Ham et al., 2016), to the best of our knowledge, it has never been characterized as a multidimensional concept. However, from the various studies of EA, it can be deduced that EA is a complex, multi-faceted topic (Baumgart-Getz et al., 2012) comprising personal values, knowledge, attitudes toward the environment, and behavioral components (Zsóka et al., 2013; Rahi, 2015). For instance, Ali (2015) indicates that EA includes at least two main domains. The first is the perception of environmental problems, which is related to environmental knowledge; thus, an individual's EA is strictly connected to the cognitive/experiential sphere. The second domain is strongly associated with the affective and psychological domain and concerns personal inclinations to protect the environment, which encompasses environmental values, behaviors, and attitudes (Ali, 2015). These two domains will be specifically examined and illustrated in the second section of this study.

The lack of universally applicable methods for measuring EA is another constraint for such research. Ham et al. (2016) claim that the measurement of EA based on scientific criteria has attracted interest in various fields, as measurability of concepts is important in modern research (Ham et al., 2016). However, EA, like many other abstract concepts, is extremely difficult to measure (Kokkinen, 2013). Surveys in which respondents self-assess their attitudes, behavior, and concerns using scales may provide valuable information even though they have several well-known limitations (Poortinga et al., 2004). These limitations can be mitigated using a combination of several instruments, which is what we have attempted to do in this study.

Although EA is a well-studied phenomenon, the EA of farmers specifically remains under-researched. There have been numerous studies that have tested the influence of EA on farming practices (Mzoughi, 2011; Wauters and Mathijs, 2014; Lastra-Bravo et al., 2015; Aregay et al., 2018; Oliver et al., 2020), but none have conceptualized farmers' EA as a multidimensional notion.

Therefore, in this paper, section 2 conceptualizes farmers' EA multi-dimensionally. Section 3 develops a methodological framework specifically adapted for measuring farmers' EA as a multidimensional concept, which, to the best of our knowledge, has not been attempted thus far. Section 4 shows a real-world application of this framework. We empirically validate the latent EA construct and test it on a sample of 382 farmers in northern Serbia. We assess its predictive validity in reference to the adoption of cleaner agricultural practices. We hypothesize that the level of farmers' EA will differ between those who apply selected environmentally friendly agricultural practices and those who do not. Moreover, we interpret and contextualize the empirical results based on the results of previous studies. Lastly, we provide our conclusions and recommendations for further research.

2. Theoretical Background

2.1. The Multi-Dimensional Nature of Environmental Awareness

Several studies have recognized the difficulty in applying a straightforward definition to EA (Cynk, 2017). The main reason lies in the complexity of EA, as it can only be depicted using multiple interconnected traits (Baumgart-Getz et al., 2012; Ali, 2015) that belong to both the rational/experiential and emotional/psychological domains. The former mainly includes objective and subjective knowledge about environmental issues, whereas the latter comprises a wide range of values and attitudes toward the environment (Ham et al., 2016).

In this study, we developed a latent construct of farmers' EA as a multidimensional notion, since such a broad approach is still lacking in the literature. In the following paragraphs, we explain each of the selected dimensions of farmers' EA, namely, environmental knowledge, environmental values (in terms of biospheric concern and connectedness to nature), environmental attitudes, and environmental behavior.

The first main domain of farmers' EA is environmental knowledge, which refers to the level of farmers' knowledge of environmental problems (global, regional, and local) and possible solutions to these problems (Bamberg and Möser, 2007). Moreover, the literature identifies two types of environmental knowledge: i) objective knowledge, which represents how much the individual really knows about the environment, and ii) subjective knowledge, which represents how much an individual thinks they know about the environment (Vicente-Molina et al., 2018).

The second domain concerns psychological and emotional aspects, including personal values. Values are mental constructs representing abstract and desirable goals, and they provide broad guiding principles for each individual's decision-making process, thus unconsciously influencing their behavior (Dietz et al., 2005; Siebert et al., 2006). According to Hansla et al. (2008) and Caracciolo et al. (2016), some value orientations are positive predictors of pro-environmental attitudes and behavior. For example, self-enhancement value orientations (e.g., power or success) show a negative relationship with environmental attitudes and behavior. By contrast, self-transcendence value orientations correlate positively. This applies both to altruism in a wider sense, that is, universalism (social justice, equality, and peace on earth) as well as to altruism in a narrow sense, that is, benevolence (loyalty, forgiveness, and responsibility) (Hansla et al., 2008).

More generally, EA has been proven to vary between those whose beliefs are anthropocentric and those whose beliefs are biospheric (Tuna, 2004). According to the

anthropocentric paradigm, people dominate the environment and nature possesses value for human use, which is the main reason it needs to be protected (Nordlund and Garvill, 2003). By contrast, under the biospheric paradigm, nature has value not only for human use but also for itself (Tuna, 2004).

Mayer and McPherson Frantz (2004) consider that for the assessment of EA, among other things, it is necessary to determine an individual's connectedness to nature. This refers to people's biophilia, their innate tendency to see themselves as part of nature (Wilson, 1984; Tam, 2013). Gosling and Williams (2010) have shown that people with a higher degree of connectedness to nature have a higher valuation of other living beings, which further leads to pro-environmental behavior (Gosling and Williams, 2010). In support of this, Srbinovski (2006) points out that one of the basic assumptions of environmental competence is satisfaction with the quality of the environment, which manifests through an emotional relationship with it (Srbinovski, 2006). Davis et al. (2009) believe that if an individual feels connected to nature, they are in an interdependent relationship with nature, in the sense that the welfare of nature affects their personal well-being (Davis et al., 2009). In addition, connection to nature influences thinking and decision-making. Leong et al. (2014) assume that individuals who are closer to nature are more likely to approach problems in a holistic and innovative way (Leong et al., 2014). Furthermore, if a person felt completely connected with nature, they would experience its destruction as a process of self-destruction (Suzuki et al., 2007).

Environmental attitudes are another key domain in the EA concept. Environmental attitudes can be defined as psychological preferences expressed in relation to the environment (Milfont and Duckitt, 2010). Past research has determined the EA of individuals by measuring their attitudes toward environmental issues, showing the validity of this method in predicting environmentally responsible behavior (Whitmarsh and O'Neill, 2010; Greiner 2015).

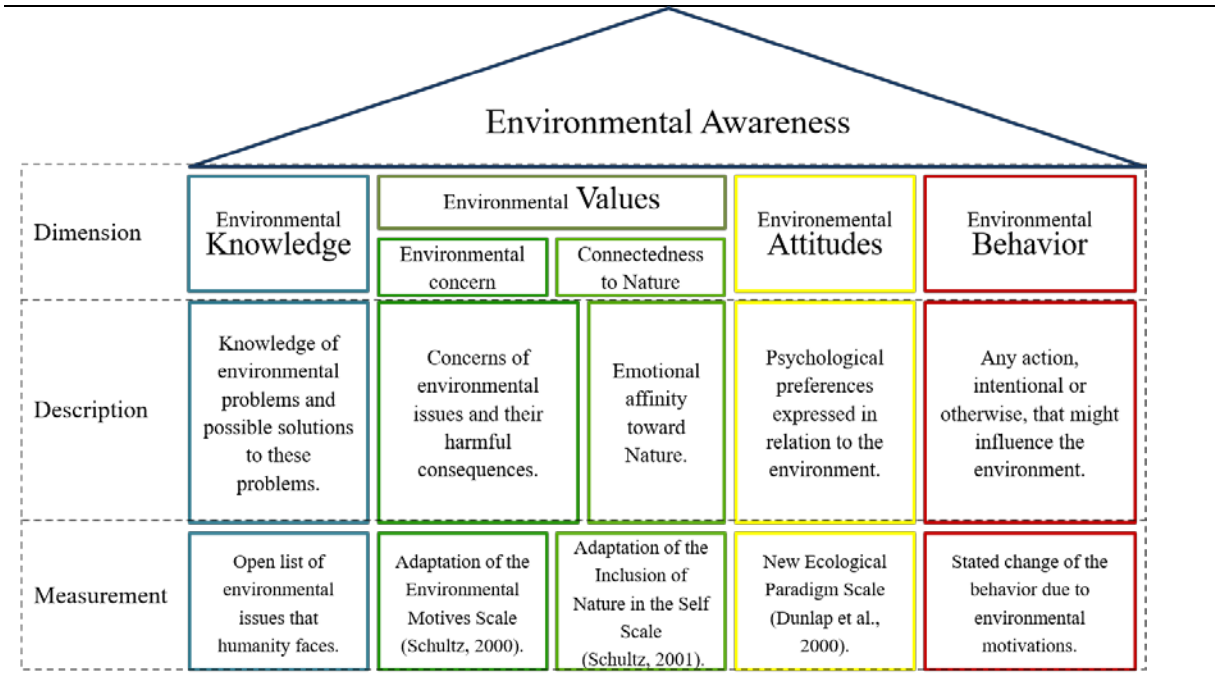
148 However, several authors have highlighted that environmental attitudes, when used alone,
149 may fail to explain the complexity of environmentally responsible behavior. Respondents may
150 choose to opt for responses they feel are socially acceptable (Olli et al., 2001; Wang et al.,
151 2014), over responses that truly reflect their feelings and beliefs (Poortinga et al. 2004).

152 Lastly, environmental behavior is a domain that significantly reflects farmers' EA.
153 Environmental behavior refers to any action, intentional or otherwise, that might influence the
154 environment (Macovei, 2015). It includes activities undertaken to minimize individuals'
155 negative impact on the environment (Kollmuss and Agyeman, 2002), for instance, the
156 reduction of one's ecological footprint (Abdul Latif et al., 2013).

157 Figure 1 graphically represents the complexity of the EA concept, featuring all the
158 components described above.

159

160 **Figure 1**. Multi-Dimensional Nature of Environmental Awareness



161 **Fig. 1** illustrates the environmental awareness as rooted on four pillars: Environmental
162 Knowledge, Environmental Values, Environmental Attitudes and Environmental Behavior.
163 Each dimension is shortly defined and the used measurement instrument or scale is presented.

In the next section we empirically develop the concept of farmers' EA and suggest instruments to measure each dimension.

2.2. Environmental Awareness Measures

Existing scales and instruments, whose validity and reliability have been formally proven and tested, are often used to measure EA. However, previously developed instruments rarely recognize the complex and multi-dimensional nature of EA, as illustrated in the previous section. Indeed, most of these instruments use only attitudes and/or environmental knowledge as measures. This framework is too limited (Poortinga et al., 2004; Kokkinen, 2013). However, starting from scratch is not a simple task: Creating completely new scales and measurement instruments is a long, complex, and uncertain venture, with the risk of duplicating existing scales, in other words, "reinventing the wheel" (Morgado et al., 2017). The development of new scales requires systematic procedures that necessitate theoretical and methodological rigor, including repeated tests and validation of the hypothesized relationships in different contexts. Any failure (i.e., missing data, social desirability bias) runs the risk of undermining the entire process (Morgado et al., 2017).

Thus, in order to achieve a better measurement of farmers' EA without creating completely new scales and measuring instruments, it would be more efficient to apply existing measurement scales and instruments and merge their information to create something new. This is the approach adopted by this study. The following sections describe each component of farmers' EA as well as the measurement scales and instruments used to quantify these components.

2.2.1. *Environmental Knowledge*

As discussed in Section 2, there are two types of environmental knowledge: subjective and objective. When surveying EA and some of its elements, participants may want their responses to be consistent with those of others. They may also want to represent themselves in a better manner, based on their perceptions of the researcher's expectations (Lange and Dewitte, 2019). Thus, the assessment of the subjective knowledge of individuals could result in a distorted image of their real knowledge. The Ninth Annual National Report Card on Environmental Attitudes, Knowledge, and Behaviors (2001) shows a large discrepancy between self-assessed and objective knowledge. Namely, 11% of Americans rate themselves as having "a lot" of environmental knowledge, and 59% of Americans rate themselves as having "a fair amount." However, in a study by NEETF, only one-third of (American) participants passed a simple test on environmental knowledge (NEETF, 2001). Therefore, in our study, objective environmental knowledge was chosen as the more reliable metric (Ham et al., 2016). Environmental knowledge (EK) was measured by the number of correctly stated environmental problems that humanity faces today. In particular, the objective knowledge of farmers regarding environmental problems was measured. This was done by asking respondents to indicate as many environmental problems as they could. The greater the number of environmental problems they correctly stated, the greater their score for environmental knowledge.

2.2.2 *Environmental Values*

In order to quantify farmers' environmental values, our construct incorporates the Environmental Motives Scale (EMS) (Schultz, 2000) and Inclusion of Nature in the Self Scale (INS) (Schultz, 2001).

Based on the Stern theory (Stern and Dietz, 1994), the EMS measures the biospheric concern that individuals feel toward the environment (Schultz, 2000). The original scale consists of 12 items of concern grouped in three categories: biospheric (plants, marine life, birds, and animals), altruistic (my community, all children, all people, future generations), and egocentric (me, my health, my future, and my lifestyle). In this paper a simpler scale is used. Farmers were asked to rank the reasons for environmental concern (all children, plants, me, animals, my future, and all people) from the most important (6) to the least (1). We summed up the ranks given to plants and animals for each individual, to create a biospheric concern score ranging from 3 to 11, where 11 indicates the highest possible biospheric concern and 3 the lowest.

The INS is one of the most interesting measures of the self–nature relationship (Schultz, 2001). It is based on a graphic representation of the possible degree of connectedness between nature and the individual. It is an adaptation of a Venn diagram (a series of pairs of circles with different levels of overlapping) created by Aron et al. (1992) (Davis et al., 2009) to measure the connectedness of an individual with others (where one circle represents the individual ("I"), and the other circle represents individuals with whom the connectedness is measured ("partner")). Circles in the Schultz INS scale represent individuals and nature. This scale has become a widely accepted instrument for measuring the connectedness of an individual to nature.

We use the INS to measure farmers' connectedness to nature. While the original INS provides seven images that show different levels of overlaps between nature and individuals, for the purposes of this study, the scale is reduced to five images. We believe that this improves its clarity and comprehensibility and does not impair the precise assessment of the relationship between farmers and nature (Figure 2).

Figure 2. Simplified Version of Schultz's INS Scale (Inclusion of Nature in Self Scale)

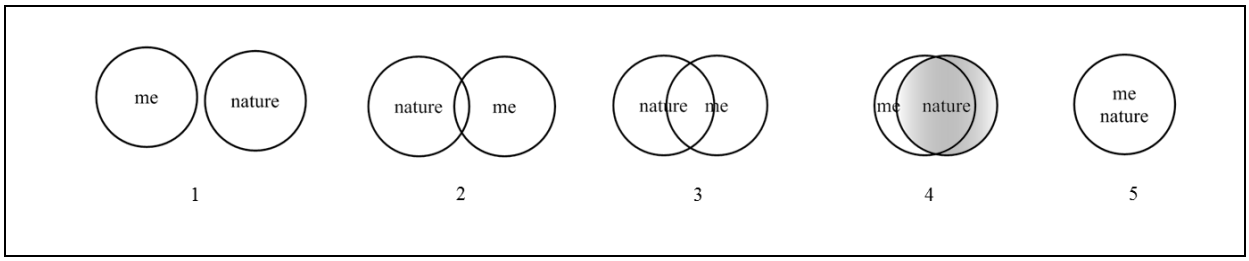


Fig. 2 shows adapted Inclusion of Nature in Self Scale (Schultz, 2001) where five pairs of different overlapped circles represent various levels of self-nature relationships. Source: Authors based on original INS scale (Schultz, 2001).

2.2.3 *Environmental Attitudes*

Measuring a general set of beliefs or attitudes toward the environment can contribute to the assessment of EA (Thapa, 1999). The New Ecological Paradigm or NEP scale (Dunlap et al., 2000) is most commonly used to assess fundamental attitudes toward the environment (Dunlap et al. 2000). The main purpose of the NEP scale is to measure the Individuals' transition from the Dominant Social Paradigm (DSP) to a new ecological world view. The NEP essentially represents a new view of the world, whereas the DSP represents the old view.

For all 15 items listed on the NEP scale, answers are given on a five-point Likert scale (1 = strongly disagree and 5 = strongly agree). The negatively worded items are reverse coded prior to statistical analysis. The total scores of all the items are added, with possible values ranging from 15 to 75.

2.2.4 *Environmental Behavior*

A self-reported, intent-oriented, and single-item approach was chosen to measure farmers' environmental behavior (EB). The literature shows two main strategies for the measurement of environmental behaviors: intent-oriented strategies and impact (goal)-oriented strategies (Gkargkavouzi et al., 2019). Intent-oriented measures are focused on voluntary activities that aim to benefit the environment, while impact-oriented measures seek to identify target behaviors that significantly affect the environment (Bamberg and Rees, 2015). Regarding methodological approaches, Lange and Dewitte (2019), in their review, discuss various approaches to measuring environmental behavior and classify measurement tools based on three categories: self-reporting assessments, field observations, and laboratory observations. Self-reporting assessments can target different behavioral properties such as private or public behavior, specified or unspecified time frames, and specified or general behavior using single or multi-item scales (Lange and Dewitte, 2019).

Following a self-reported, intent-oriented, single-item approach, the EB in this study was measured by the question: "Have you changed your behavior due to environmental reasons?" This question encompasses past and present behavior changes, and whether these changes have been sustained. Nonetheless, there is a possibility that some people are unaware that their activities benefit the environment. However, the focus of this study is on the actions that farmers consciously undertake to benefit the environment.

3. Data and Methodology

In order to illustrate the usefulness and validity of the farmers' EA construct developed in this study, we undertook an empirical application by measuring farmers' EA in the Vojvodina

region, the main agricultural area in the Republic of Serbia. Vojvodina is characterized by agricultural activities that have negative impacts on natural resources, especially on soil (Karapandžin and Rodić, 2017). Vojvodina's vulnerability is reflected in the lack of windbreaks and intensive crop production, which lead to soil erosion, loss of fertility, and increased land degradation. Inadequate soil management, which includes intensive farming with a typically poor rate of soil nutrient replenishment and a decrease in the humus content continually impairs the quality of the land (Puzović i Radovanović-Jovin, 2011). Therefore, a better understanding of the factors affecting farmers' adoption of cleaner agricultural practices would greatly benefit this region (Despotović et al., 2019).

3.1. Data Collection and Survey Development

EA was measured with a sample of 400 farmers (field crop producers) in the Vojvodina region. Farmers anonymously and voluntarily participated in the survey. The survey employed a stratified sampling design using municipalities as strata according to official agricultural statistics (SORS, 2012). The questionnaire consisted of several sections, including sections on farmer demographics, structural information about their farms, different components of farmers' EA, and adoption of specific environmentally friendly agricultural practices (reduced tillage, growing perennial crops, cover crops, mulching, biological pest control, and green manure) [1]. Agricultural practices were selected based on whether they were important for sustainable soil management and had a low acceptance rate among the farmers of Vojvodina (SORS, 2012). The final version of the questionnaire was assessed using a pilot study with 10 farmers. Minor changes were made in accordance with the suggestions of the participants of the pilot study. The parts of the survey dealing with EA components implemented from the literature were translated to Serbian following forward and backward translation.

[1] The part of questionnaire relevant to the research presented in this paper is provided in Appendix A.

The survey was conducted from April 2017 to January 2018 through one-on-one interviews, which ensured a high response rate. After rejecting incomplete questionnaires, the total sample size was 382. It should be noted that farming systems in the survey area are remarkably similar in terms of crop structure and applied agricultural technology[2].

3.2.Data Analysis

Considering the multi-dimensional nature of the EA concept, we employed structural equation modeling (SEM). The choice of SEM is often driven by the need to design and quantify theoretical concepts that cannot always be directly observed and evaluated (personality, attitudes, motives, emotions, and abilities) (Hoyle, 2012). In this research, SEM was used to develop the latent farmers' EA construct, examine and merge the information provided by the different measurement tools, and statistically validate the internal consistency of the EA construct and its functionality.

We estimated the following measurement model (a confirmatory factor analysis), which includes the relationship between the latent variable and its components, for the *i*-th respondent:

$$\mathbf{x}_i = \mathbf{\Lambda} EA_i + \mathbf{u}_i \quad \text{(eq. 1)}$$

where the latent construct EA is linked to the *p*-vector of the observed measurement instrument **x** (EK, BC, INS, NEP, and EB) through the *p*-vector of parameters $\mathbf{\Lambda}$ (or loadings), and **u**, the *p*-vector of measurement errors.

Finally, we used a *t* test to compare the differences in EA between groups of farmers that show different levels of adoption of environmentally friendly agricultural practices.

[2] Five basic crops (corn, wheat, sunflower, soybean, and sugar beet) occupy as much as 85% of the total arable land in Vojvodina region (1.55 million hectares).

4. Results

Table 1 shows the socioeconomic profiles of the sampled farmers. The average age was 41.4 years (SD =12.7), with the age range being 20–82 years. The average farm size was 51.28 hectares, which means that the sample consisted of larger farm [3]. Other recorded characteristics of the farmers included gender, education level, and past experience in agriculture in years (Table 1).

Table 1. Descriptive Statistics of the Sample

Variables	Range/Relative Frequency %	Mean	Std.dev
Gender	male (=1) 97.91 female (=0) 2.09	0.98	N/A*
Age	≤45 (=1) 62.30 >45 (=0) 37.70	0.62	N/A*
Education	elementary school (=0) 10.73 high school (=1) 73.30 university (=2) 15.97	1.05	N/A*
farm size (ha)	10-200	51.28	40.34
experience in agriculture	2-64	20.70	11.47

*N/A – not applicable
N=382

Table 2 shows the descriptive statistics of the different scales and instruments used for developing the farmer EA construct. As mentioned in Section 2.2.1, objective environmental knowledge was measured by the number of environmental problems correctly stated by farmers. The greater the number of environmental problems correctly stated, the greater the environmental knowledge score. The average number of correctly stated problems was 2.66. 95% of the farmers correctly indicated at least one environmental problem that humanity faces today. Climate change and associated problems such as global warming and extreme weather

[3]According to the Census of Agriculture (SORS, 2012), the average farm size in Vojvodina Province was 10.9 ha.

conditions (drought was most often mentioned, followed by floods, strong winds, and extreme temperatures) were the most frequent response.

The environmental values component was measured through biospheric concern, using the revised EMS scale, and farmers' connectedness to nature, using the revised INS scale. The majority of respondents (36.4%) ranked plants and animals lowest among the offered reasons for environmental concern (biospheric score = 3), while only 1.3% of farmers expressed the highest environmental concern for plants and animals (biospheric score = 11).

The revised INS scale showed that the vast majority of respondents felt connected to nature. The farmers who felt completely united with nature chose fully overlapping circles, indicating that the individual and nature are in complete unity. A majority, 59.4% of respondents, chose this option (item 5 in figure 2). Almost fully overlapping circles were chosen by about a third of the respondents (28.80%) (item 4 in figure 2). By contrast, only 0.2% of farmers felt completely detached from nature (item 1 in figure 2).

Farmers' environmental attitudes were measured using the NEP scale. The average aggregate NEP score of sampled farmers was 3.60 (53.95/15 items).

The last EA component, environmental behavior, was measured through a self-reported change in the behavior of the respondents. Three quarters of respondents indicated that they have changed their behavior for environmental reasons.

Table 2. Descriptive Statistics of Environmental Awareness Measures

Measure	Description	Mean	Std.dev
Environmental knowledge	Number of reported environmental issues	2.66	1.66
Biospheric concern	Aggregation of responses to two biospheric object of concerns (min 3, max 11)	5.41	2.26
INS	1 = completely deatached to 5 = completely united with nature	4.45	0.77
NEP	Aggregation of responses to 15 NEP questions	53.95	7.09
Previous change in environmental	0 = no, 1 = yes	0.75	N/A

behaviour
*N/A – not applicable
N=382

4.1. Construct Measurement and Use

Table 3 shows the correlation matrix of the measurement instruments based on which the farmers' EA construct was developed. The correlation values are generally small and positive, which indicates complementarity rather than overlap among the different domains and scales included in the EA framework.

Table 3. Spearman Correlation Matrix

	EK	**BC**	**INS**	**NEP**	**EB[a]**
EK	1.000				
BC	0.177**	1.000			
INS	0.003	0.107*	1.000		
NEP	0.265**	0.108*	0.138**	1.000	
EB[a]	0.275**	0.105*	0.133**	0.059	1.000

**p<0.01; *p<0.05
[a] Pearson correlation was used for dichotomus variable

Relying on the theoretical model illustrated in section 2, and using the instruments described in section 3, the farmer EA construct was empirically assessed through SEM. Moreover, the results provide evidence of the validity and suitability of the estimated construct for assessing the level of farmers' EA.

As shown in Figure 3, all of the selected indicators contribute to defining the latent EA construct. The correlation between EA and each element (factor loadings) ranged from 0.83 for environmental knowledge to 0.23 for biospheric concern, which is larger than 0.2 (the value for rejection from the model) (Chin, 1998). The estimated model satisfies the selected

goodness-of-fit indices[4] based on Hu and Bentler (1999) and Hooper et al. (2008). The results indicate that the indicator that makes the greatest contribution to farmers' EA construct is environmental knowledge (factor loading = 0.83), while connectedness to nature (INS) is the second most influential factor (factor loading = 0.45) (Figure 3).

Figure 3. Environmental Awareness as a Latent Construct

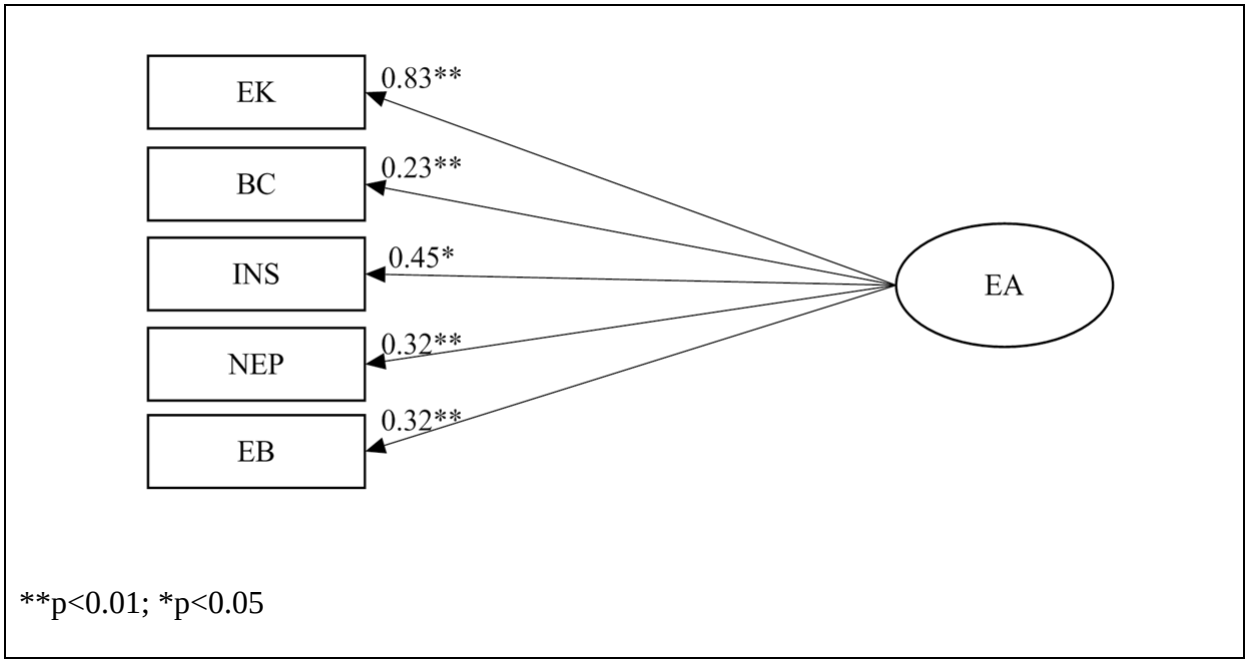


Fig. 3 shows SEM results with the contribution of the selected indicators to defining the latent environmental awareness (EA) construct. Environmental knowledge (EK) has the highest contribution (factor loadings = 0.83), followed by connectedness with nature (INS), environmental attitudes (NEP), environmental behavior (EB) and biospheric concern (BC) whose factor loadings are 0.45, 0.32, 0.32 and 0.23, respectively.

Once we validated the farmers' EA construct, we estimated the level of EA for each farmer in the sample. Then, we compared the estimated values for groups of farmers categorized based on whether they adopted specific environmentally friendly agricultural practices. This comparison shows whether the latent EA construct is associated with differences in farmer behavior in relation to farming management practices.

[4] χ^2 2.32 (p-value 0.68); TLI 1.05; CFI 1.00; RMSEA >0.01; SRMR = 0.02

The results show that the level of EA in farmers who adopted biological pest control, green manure, or mulching is higher (+23%, +9%, and +17%, respectively) and statistically significant compared to those who did not adopt these farming practices (Table 4).

By contrast, farmers who adopt the practices of reduced tillage, grow perennial crops, and use cover crops show EA values that are not statistically different from those of farmers who did not apply these practices.

Table 4. T-test of Group Difference in Level of Environmental Awareness

Practices	Groups	obs	Mean	Std.dev	p-value	t-stat	Difference (%)
Reduced tillage	yes	222	9.857	2.106	0.926	0.093	-0.2
	no	160	9.878	2.286			
Growing perennial crops	yes	132	9.905	2.264	0.798	-0.256	0.6
	no	250	9.845	2.137			
Cover crops	yes	4	11.043	3.246	0.278	-1.087	12.1
	no	378	9.853	2.168			
Mulching	yes	9	11.47	2.744	0.025	-2.248	16.7
	no	373	9.827	2.153			
Biological pest control	yes	7	12.082	2.906	0.006	-2.739	23.0
	no	375	9.824	2.147			
Green manure	yes	34	10.658	2.067	0.026	-2.233	8.9
	no	348	9.788	2.177			

5. Discussion

For decades, measuring EA has involved the development of new methods and scales. The complexity of the concept of farmers' EA necessitates complex measurements involving different elements of EA. For instance, Kollmuss and Agyeman (2002) state that developing a model including all EA dimensions was probably not feasible, given the excessive complexity of the problem. Instead, it is more appropriate to identify the most relevant elements. Our study also faced this challenge, significantly contributing to the literature by discussing, developing, and implementing EA as a multidimensional concept. The study is novel in that we are the first to develop a unique construct that includes several domains such as environmental knowledge, biospheric concern, connectedness to nature, environmental attitudes, and environmental behavior.

Among the selected dimensions affecting sampled farmers' EA, our study identified environmental knowledge as the most relevant. This is in accordance with Liobikienė and Poškus, who claim that ecological knowledge is of utmost importance for those seeking to promote pro-environmental behavior (Liobikienė and Poškus 2019). Kokkinen (2013) also considers environmental knowledge as a crucial element in the development of EA, since knowledge allows individuals to be aware of nature's limitations and the threats to natural systems. Based on the numerous environmental problems that respondents perceived, both in their immediate environment and globally, it can be concluded that knowledge of environmental problems is not a limiting factor in the development of farmers' EA. However, there is a lack of knowledge about possible solutions to the identified environmental problems, which is a "weak link" that needs to be worked on to strengthen EA.

The second most important dimension in farmers' EA is environmental value and, in particular, connectedness to nature. The latter is often indicated in the literature as a crucial

445 component of pro-environmental behavior (Braun and Dierkes, 2016). Kals et al. (1999) and
446 Lokhorst et al. (2014) have shown that affinity to nature is directly related to intentions and
447 decisions regarding conservation behavior. Müller et al. (2009) argue that emotional affinity
448 to nature is a strong predictor of environmental behavior, and that feeling responsibility
449 toward nature provides a stronger motivation for long-term environmental commitment than
450 situational appeals that can only create temporary change. Hinds and Sparks (2008) emphasize
451 that experience in nature is significantly correlated with pro-environmental behavior such as
452 recycling, signing petitions for environmental protection, and the use of public transport, and
453 that frequent exposure to nature can encourage positive feelings toward nature. Leong et al.
454 (2014) similarly state that it is very likely that authentic, repetitive interactions with nature can
455 develop individuals' sense of connection with nature and that individuals connected with
456 nature will have a greater need to stay in nature.

457 The third and fourth most important factors determining EA are attitudes, measured by the
458 NEP scale, and environmental behavior. The average aggregated NEP score of sampled
459 farmers is 3.60, which is in line with the average NEP scale score of farmers in New Zealand
460 (3.6) (Durpoix, 2010), slightly below the score in Denis and Pereira (2014) for urban
461 households in Romania, and slightly above the score calculated by the same authors for urban
462 households in Portugal.

463 Olli et al. (2001) and Chen et al. (2011) state that higher NEP scale values encourage
464 environmentally responsible behavior as the ultimate goal of EA; however, Whitmarsh and
465 O'Neill (2010) disagree and state that the high NEP values do not affect environmentally
466 responsible behavior. Durpoix (2010) showed that farmers accept the new environmental
467 paradigm more than the dominant social paradigm (Durpoix, 2010). In our survey, farmers
468 mainly agreed on NEP items; however, they did not heavily disagree with the DSP items,
469 which suggests that farmers accept the new ecological worldview, but that they do not

sufficiently reject the dominant social paradigm. A possible explanation for this result is provided by Denis and Pereira (2014), who state that technological optimism and belief in nature as an unlimited resource is still strongly rooted among many, especially those who still subscribe to the DSP paradigm (Denis and Pereira, 2014).

Although the magnitude of biospheric values has previously proven to be a significant predictor of the application of environmental practices (Milfont et al., 2006; Price and Leviston, 2014), in our study, biospheric concern contributed the least to the latent construct of farmers' EA.

Our findings highlight the importance of farmers' EA in the adoption of more environmentally friendly agricultural practices. A higher level of EA is associated with a higher rate of adoption of certain environmental agricultural practices (biological pest control, green manure or mulching), even though there were no statistically significant differences in other practices (reduced tillage, growing perennial crops, and using cover crops). One possible explanation for the low effect on "reduced tillage" is that there are several economic benefits to the adoption of this practice (Townsend et al., 2016); therefore, there are many reasons beyond environmental concern why farmers may adopt it (Canales et al., 2018). Concerning the cultivation of perennial crops (mainly alfalfa), this practice is driven more by the needs of livestock production than by the needs of the environment (Asbjornsen et al., 2013; Wezel et al., 2014). Finally, the absence of a statistically significant contribution of the cultivation of cover crops to the latent construct of farmers' EA may be due to the very low prevalence of this practice in our sample (only four farmers engaged in this agricultural practice).

This study also provides political and practical implications. The EA construct developed in this study could be easily applied to different contexts as an operative tool for assessing farmers' EA and their natural tendency to adopt cleaner agricultural practices. Once the construct is implemented, its outcomes could be useful for policymakers and extension

services to better understand factors that inhibit or facilitate farmers in reducing their environmental impact. Such research is invaluable for its ability to facilitate informed policy development and the design of appropriate measures. For instance, our results indicate the importance of environmental knowledge, which indicates to policymakers that institutional and non-institutional environmental education for farmers could be very effective in getting them to adopt more environmentally friendly practices. Knowledge can also be improved through awareness programs; advisory services should offer advice on sustainable agricultural practices and emphasize their usefulness, as well as the usefulness of general environmental conservation. This way, policymakers can ensure that farmers develop an awareness of the effects that their choices have on the environment. This will encourage farmers' intrinsic desire for environmental protection and stabilize changes in behavior, potentially achieving a region-wide reduction in the negative environmental impacts of agriculture.

5.1 Limitations and Recommendations

This research is not exempt from limitations, some of which pave the way for future research. Due to the self-reported nature of the data collected in this study, we are aware of the limitations that social desirability and other biases impose on data quality. These shortcomings are inherent to the survey method (Olli et al., 2001; Rodić and Kostić, 2011; Wang et al., 2014), although good survey design can mitigate them as much as possible. We have tried to minimize the impact of this limitation through careful sample selection, questionnaire design, implementation of pilot research, appropriate training of interviewers, and more.

Further research could explore other potential EA components such as environmental education and social embeddedness, which have been proven to be effective in previous

research (Migliore et al., 2014). Moreover, there are many other possible factors (i.e., type of crops) that can potentially affect both the adoption of the selected environmentally friendly agricultural practices and the relative impact of EA. While the sample of this study was highly homogenous in terms of cropping systems, examining other cropping systems and the differences between them in terms of EA and their effect on the choice of farming practices is left for future studies.

6. Conclusions

Farmers' decisions are not only driven by economic incentives—their attitudinal/behavioral characteristics also play a significant role in influencing their choices. This study discussed the importance of farmers' EA in affecting their choice of farming practices. Recognizing the complexities inherent in EA, this study developed and implemented a multi-dimensional construct for measuring farmers' EA. The developed instrument can be easily applied to different contexts by researchers and practitioners for measuring farmers' EA and promoting environmentally friendly food production. Moreover, this study provides significant insights for policy makers and advisory services to help design their strategies for improving environmental awareness, as it highlights what aspects of environmental awareness have the most impact on the likelihood of environmentally friendly behavior.

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APPENDIX A. QUESTIONNARIE EXAMINED IN THE ARTICLE

1. DEMOGRAPHIC DATA

1.1 Gender?

☐ male
☐ female

1.2 Age? _____

1.3 Education level?

☐ Elementary school
☐ High school
☐ College or University degree

1.4 Experience in agriculture (years)? _____

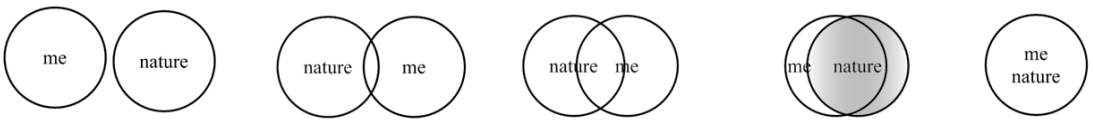
1.5 Farm size (ha)? _____

2. ENVIRONMENTAL AWARENESS

2.1 Please rank from 1 (the least concerned) to 6 (the most concerned) how concerned are you about the impact of environmental problems on given areas:

__ Plants __ Children __Animals __Me __My future __All people

2.2 Please circle the picture below that best describes your relationship with the natural evnironment. How interconnected are you with nature?



2.3 Have you changed your behavior due to environmental reasons?

☐Yes ☐No

2.4 Listed below are statements about the relationship between humans and the environment. For each one, please indicate whether you Strongly Agree (SA), Mildly Agree (MA), are Unsure (U), Mildly Disagree (MD) or Strongly Disagree (SD) with it.

No.	Do you agree or disagree that:	SA	MA	U	MD	SD
1.	We are approaching the limit of the number of people the earth can support.					
2.	Humans have the right to modify the natural environment to suit their needs.					
3.	When humans interfere with nature it often produces disastrous consequences					
4.	Human ingenuity will insure that we do not make the earth unlivable.					
5.	Humans are severely abusing the environment.					
6.	The earth has plenty of natural resources if we just learn how to develop them.					
7.	Plants and animals have as much right as humans to exist.					
8.	The balance of nature is strong enough to cope with the impacts of modern industrial nations.					
9.	Despite our special abilities humans are still subject to the laws of nature.					
10.	The so-called "ecological crisis" facing humankind has been greatly exaggerated.					
11.	The earth is like a spaceship with very limited room and resources.					
12.	Humans were meant to rule over the rest of nature.					
13.	The balance of nature is very delicate and easily upset.					
14.	Humans will eventually learn enough about how nature works to be able to control it.					
15.	If things continue on their present course, we will soon experience a major ecological catastrophe.					

2.5 Please list the environmental problems that humanity faces today

_____

2.6 Please select the environmentally friendly practices that your farm adopts.

☐ Reduced tillage
☐ Growing perenial crops
☐ Cover crops
☐ Mulching
☐ Biological pest control
☐ Green manure