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Determinants of Farmers' Intention to Adopt Water Saving Measures: Evidence from Italy

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Abstract: The present research is aimed at establishing how farmers can be encouraged to adopt irrigation water saving measures. By developing and implementing an extended version of the well-known Theory of Planned Behavior, we considered farmers' propensity to adopt innovations and their water footprints. In a sample of 150 Italian farmers, we found that favorable attitudes towards water saving measures, and the orientations of environmental associations and public bodies favorably influence farmers' intentions to adopt water saving measures. Farmers' innovativeness and water footprints also exert a significant influence on their adoption intentions. The paper also discusses the contribution of these results to the previous literature and highlights practical implications for policy makers interested in promoting the adoption of irrigation water saving measures.

Keywords: water saving measures; Theory of Planned Behavior; Italy; agriculture

1. Introduction

The effective management of water resources is becoming a priority for many countries worldwide [1]. Due to ongoing industrialization and urbanization processes, production sectors are increasingly absorbing limited water resources [2], whereas unplanned and excessive water consumption is leading to the depletion of groundwater basins, with significant negative consequences for natural habitats and ecosystems [2]. Farmers' consumption of irrigation water may represent up to 90% of a nation's water consumption [3,4]. As a consequence, farmers represent a critical target of water saving and efficiency enhancement policies.

Technology can significantly contribute to controlling water consumption in the agricultural sector and has favored the development of irrigation techniques—from micro-drip to intermittent and/or sprinkling irrigation, to plastic sheeting, etc. [5]—which could be particularly effective in saving water resources and freeing them up for other uses. Such techniques may also increase yield quality and quantity whilst saving water. Therefore, many national governments currently seek to highlight the importance of reducing water consumption in agriculture and motivate farmers to improve their irrigation techniques by providing incentives for the adoption of water saving measures.

In many countries, the adoption rate remains regrettably low [6]. This problem is particularly relevant in Italy, which is the third largest European user of water after Greece and Spain [7]. Northern regions, in particular, are the largest consumers of groundwater, while their irrigation techniques are less efficient than those in the Central and Southern regions [8]. Thus, regional policies currently promote the replacement of obsolete irrigation systems by providing farmers with subsidies that may cover almost 40% of their needed investments [9,10].

A relevant question, however, is how to increase farmers' sensitiveness to water saving and encourage them to adopt water saving measures. Investigating the factors most likely to impact on farmers' adoption intentions could allow policy makers to target them through ad hoc communication policies. Until now, empirical research on such factors underlying farmers' intentions to adopt water saving measures has been extremely limited, despite the worldwide relevance of this topic. Therefore, the present work embraced the Theory of Planned Behavior (TPB) [11], a well-known framework in psychological literature, to assess the determinants of Italian farmers' behavioral intentions, and extended the model by also considering farmers' innovativeness, intended as their tendency to develop and/or adopt new technologies [12–14] and their water footprint (WF), that is, the amount of freshwater they consume for their production processes [15,16]. The WF provides information about farmers' direct and indirect water-consumption processes for each crop cultivation [17] by adopting a life cycle approach ("from cradle to grave"). It is a measure of the overall water volumes consumed and/or polluted for each production unit (i.e., per crop) over the growing period assessed at the point of production [15,18]. It is a reliable indicator of the impact of farming on water resources because it considers the multiple aspects of such an activity, which is consistent with a holistic approach to sustainability assessment [19].

The paper proceeds as follows: the next section introduces Ajzen's TPB framework [11] and illustrates the notions of farmers' innovativeness and WF, which could help understand more in depth farmers' intentions to adopt water saving measures. Then, the paper presents the methodology followed to implement our study and the results obtained. The last two sections, respectively, discuss our results and, based on the research limitations, provide suggestions for future research.

2. Background

2.1. The Theory of Planned Behavior and Water Saving Measures

Ajzen's Theory of Planned Behavior (TPB) [11] is a socio-psychological model which postulates that a person's (e.g., in a firm, a decision-maker's) intention to enact a given behavior is the strongest predictor of that behavior. In turn, intention is a function of three principal determinants: attitude toward the behavior (ATT), i.e., the level of an individual's favorable or unfavorable propensity towards a specific behavior; subjective norm (SN), i.e., the degree of social pressure that influential others exert on individuals, leading them to adopt or not adopt a specific behavior; and perceived behavioral control (PBC), i.e., the individual's perception of the level of easiness or difficulty of accomplishing that specific behavior. Each of these constructs derives from a set of beliefs that respectively regards: the advantages vs. disadvantages related to the considered behavior (behavioral beliefs); the persons or organizations that may support it or not (normative beliefs); and the perceived ease vs. difficulty of performing it (control beliefs). This model has been used to assess the cognitive factors determining people's water saving and reduction behavior and, occasionally, to assess farmers' water saving intentions.

The relevance of the TPB in predicting water saving consumption derives from the fact that such a behavior is not only influenced by "external" factors—from water pricing and distribution to water policies, to the cost of water saving measures, the availability of information about water saving measures, their practicality, etc.—but also by conditions and motivational forces regarding the single decision-maker [20]. Indeed, the perceived inconvenience and the costs of water saving appliances may weaken people's water saving intentions [21]. On the opposite end, income and education may positively influence people's water saving intentions [22], as well as receptiveness of water saving-related information [23] and concerns over future water shortage [24].

Regarding individuals' inherent motivational forces, previous research has found that the TPB variables effectively predict people's intentions to save water [24–26]. Lam [25] also sought to extend the model by including a measure of people's perceived moral obligation to reduce water consumption, but found no significant effect for this variable. Recent research has attempted to better specify the nature of perceived moral obligation by focusing on the extent to which individuals care for their environment (so-called "environmental value orientation"). However, results regarding the impact of this variable on water saving intentions remain contradictory. For instance, Salvaggio et al. [27] detected a significant positive effect of environmental value orientation on individuals' support for water saving policies. Whereas Clark and Finley [24] established that environmental concern is a significant, albeit weak, predictor of people's intentions to save water. On the other hand, Chang [28] and Trumbo and O'Keefe [26] found no significant effect of this variable on water saving behaviors.

Regarding farming, previous studies have used the TPB model mainly to investigate farmers' attitudes toward water saving, and—in very few occasions—their intention to adopt water saving measures. Chang et al. [29] found that farmers' favorable attitudes toward restricting water consumption predict their acceptance of water saving policies. Meanwhile, Far and Moghaddam [30] established that attitudes toward water resources management, subjective norm, and perceived behavioral control, affect farmers' attitudes toward participation in water saving projects. About the adoption of irrigation water saving measures, in particular, Lynne et al. [31] found that farmers' attitudes toward them, subjective norm, and perceived behavioral control are significant predictors of farmers' investments in such measures. This finding was partially replicated by Yazdanpanah et al. [3] who focused on the broad range of practices farmers may adopt to save and conserve water (e.g., new irrigation systems, rainwater harvesting techniques) and found that perceived behavioral control exerts a direct influence on Iranian farmers' adoption of these practices, whereas attitudes and subjective norm indirectly influence this behavior via their behavioral intentions.

However, the current understanding of the impact of the TPB variables on farmers' intentions to adopt water saving measures remains very limited, and, surprisingly, previous research has neglected to consider farmers' innovativeness, here intended as their propensity to develop and/or use new technologies, which could significantly influence the adoption of water saving measures.

2.2. The Role of Farmers' Innovativeness

Innovativeness is an individual characteristic influencing the adoption of new products, technologies, or ideas [13,14]. As for entrepreneurs, in particular, innovativeness regards their "willingness to support creativity and experimentation in introducing new products/services, and novelty, technological leadership and R&D in developing new processes" [32]. It is a tendency to be a technological pioneer [33] that results in the introduction of new processes, products, or technologies in the organization [12,34]. Indeed, innovative entrepreneurs support new ideas and engage in creative processes that lead to developing and/or adopting new products/services, technological processes, or organizational methods [32] potentially able to increase people's productivity, efficiency, income, and, ultimately, collective wellbeing. Such entrepreneurs are able to depart from existing technologies or practices, find, and experiment with new ones, and their favorable disposition toward changes [35,36] manifests through the introduction of new products/services as well as through their ability to adopt innovations earlier than their peers [37,38].

As for farming, innovativeness may refer to farmers' discovery and implementation of completely new agricultural practices (ground-breaking innovativeness) as well as the introduction of new practices that increase the effectiveness of already existing ones (incremental innovativeness) [39]. This capacity is normally heightened by collaboration with other farmers and/or agricultural research centers [40], and may also be stimulated by participation in non-farming activities [39]. Regarding the adoption of a new technology, in particular, several factors may impact farmers' decisions, some of which are directly related to that technology, whereas others regard farmers' characteristics. Specifically, with regards to new technology, its adoption may be determined, first of all, by farmers' expectations about its benefits and the extent to which it could help them achieve their objectives (i.e., its usefulness), as well as its complexity and the effort that farmers would need to learn how to use it [6,41]. The easier it is to use a new technology, the less the uncertainty about its advantages in terms of improved performances. Meanwhile, as for farmers' characteristics, extant research found that the adoption of a new technology may be positively influenced by farmers' production specialization and education [42]. Risk propensity may also have a crucial role, especially if technology costs cannot be recovered [43].

Previous studies [44,45] found that stimulating farmers' innovativeness—for instance, by promoting partnerships with researchers and technology agencies—may foster the adoption of water saving measures. This could happen especially when farmers are able to understand the principles behind such measures: Bagheri and Ghorbani [46], for example, found that Iranian farmers who were more informed about sprinkler irrigation methods were more willing to adopt them. Such awareness (which derived from the contact with experts and/or from training programs) enabled them to solve the technical problems related to the installation of the irrigation equipment. On the other hand, limited awareness of these methods determined farmers' decisions to reject them.

2.3. Water Footprint and Its Assessment

The WF is a measure of human demand for water resources for both production and consumption goals [15,47]. Allan [48] initially sought to quantify this demand by introducing the concept of "virtual water", which is the amount of water consumed to produce a given commodity, good, or service. The concept of WF is slightly more complex: it has a multidimensional nature as it considers the place where water is consumed, the type of water used, and when it is used. It is possible indeed to determine WF measures for given regions or even for a whole nation. In the latter case, the WF is a measure of the global water requirements of that nation and thus an indicator of the impact of human activities on that nation's water resources [47]. With respect to the type of water used, it is possible to distinguish three forms of WF: the *blue* WF, which is an indicator of the use of fresh surface water or groundwater; the *green* WF, which refers to the use of water derived from precipitations on land that do not feed the runoff or recharge of groundwater, but remains temporarily on the surface of the vegetation [43,49]; and the *grey* WF, which refers to the volume of freshwater necessary to dilute pollutants to such an extent that the quality of the ambient water remains above a given quality standard [38]. Meanwhile, regarding the time in which water is consumed, the WF generally refers to a year, although it is possible to compute WF time series, in order to assess how water consumption evolves over time [50].

The WF has attracted scientists' and professionals' attention on relevant issues regarding sustainable water resource management, revealing its usefulness in assessing aspects related to production processes which cannot be captured by monetary indicators [51]. For this reason, despite not being a policy tool itself, the WF of agricultural productions may offer policy-makers relevant information to guide farmers' water management decisions and help farmers deal with the problem of sustainable appropriation of freshwater [17,19,48]. By assessing water consumption during a product's life cycle, this measure provides water resource management with guidance for effective water stewardship in the agro-food sector [52,53].

The assessment of the agricultural WF yields an index, expressed in terms of volume of water consumed per mass of crop product [54]. Mekonnen and Hoekstra [55] identified such products based on the Harmonized Commodity Description and Coding System, also known as the Harmonized System (HS) of tariff nomenclature (an international system for product classification) and estimated regionally the WF of 146 crops across the world for the period from 1996–2005. The present research embraced these authors' approach to calculate the WF of a random sample of farms located in Italy.

3. Methodology

The research comprised a pilot study, aimed at identifying the behavioral, normative, and control beliefs likely to determine farmers' intentions to adopt water saving measures, and a main study aimed at implementing our extended version of Ajzen's model [11], with innovativeness and WF as additional predictors of farmers' adoption intentions (Figure 1).

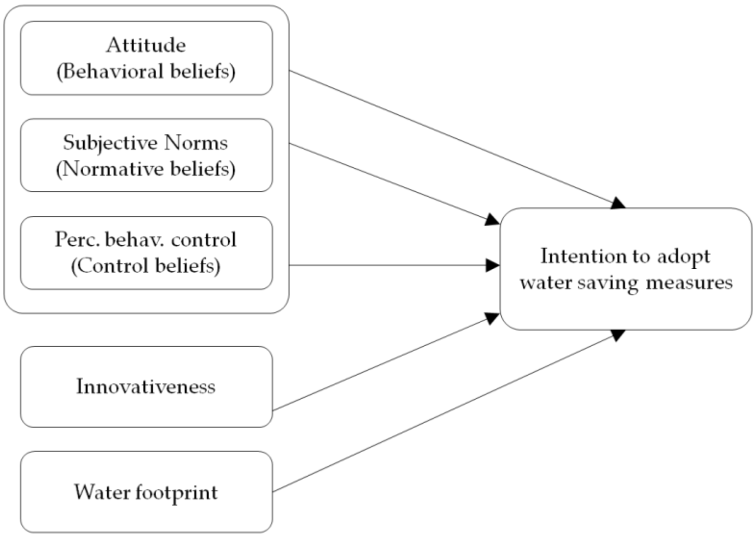

Figure 1. The research model.

3.1. Pilot Study

Procedure

The pilot study was aimed at assessing farmers' behavioral, normative, and control beliefs by means of an open-ended questionnaire that a research assistant administered via face-to-face interviews to a random sample of 40 administrators of Italian farms. Respondents completed the questionnaire by indicating: (i) the principal advantages vs. disadvantages of water saving measures that could influence their decision to adopt them (behavioral beliefs); (ii) the categories of people or organizations that may encourage vs. discourage their decision (normative beliefs); and (iii) the events or situations potentially able to facilitate vs. hinder the adoption of water saving measures (control beliefs).

3.2. Main Study

3.2.1. Sample

The main study was carried out on a random sample of farms operating in Italy through an on-line survey. Farmers' contact information was drawn from the AIDA database [56], which provides account data, economic indicators, trade description, and general information of one million farms operating in Italy. The owners or, alternatively, people responsible for technical decisions of the selected farms received via e-mail a formal invitation to participate in a survey study by completing an online questionnaire on water consumption in agriculture. Farmers operating in the forestry sector were not considered in our target population. Out of about 1000 potential participants, 150 completed the questionnaire in full. Such a low response rate (15%) is in line with previous literature (e.g., [57]). Extant research has indeed ascertained that farmers are generally unwilling to spend their time completing surveys [58] and sharing data and/or information on themselves and their activities [59]. Nevertheless, respondent results were homogeneously distributed among the North (n = 57), Central (n = 44), and South (n = 49) of Italy. The majority of farms were medium-sized, with up to ten employees (72%) and an annual income lower than 50,000 Euro (54%). Besides cultivating, half of the sample marketed agrifood products, and 36% of the sample processed them.

3.2.2. Questionnaire

The questionnaire gathered data regarding Ajzen's determinants, respondents' innovativeness, WF, and intention to adopt water saving measures. Regarding Ajzen's determinants, the questionnaire assessed, first of all, the beliefs underlying each of these constructs. In particular, behavioral beliefs were assessed by asking farmers to rate the likelihood that they could actually benefit from the advantages, and face the disadvantages identified in the pilot study; normative beliefs were assessed by asking respondents to rate the likelihood that the people and organizations identified in the pilot study would support their decision to adopt water saving measures; control beliefs were assessed by asking respondents to rate the likelihood that the positive and negative situations or events identified in the pilot study might actually occur. All these beliefs were assessed on 7-point scales (1 = "Not at all likely", 7 = "Extremely likely"). The questionnaire also included three items that respectively assessed Ajzen's determinants in a direct way. Indeed, respondents rated: their general opinion about water saving techniques, thus providing a direct measure of their attitudes toward water saving measures; the likelihood that other people and/or organizations would support their decision to adopt such measures, thus providing a direct measure of subjective norm; and the likelihood that the situations or events previously illustrated would affect their adoption decision, thus providing a direct measure of perceived behavioral control. These three items were assessed on a 7-point scale (1 = "Not at all likely", 7 = "Extremely likely").

Farmers' innovativeness was assessed through a three-item scale drawn from Agarwal and Prasad [60] ("If I heard about a new technology, I would look for ways to experiment with it"; "Among my peers, I am usually the first to try out new technologies"; "I like to experiment with new technologies"; 1 = Disagree strongly, 7 = Agree strongly). To assess farmers' WFs, respondents indicated the percentage weights of the different crops they cultivated in their farms over their global production mix. Respondents also indicated on a 7-point scale the likelihood that they would adopt water saving measures within the next two years (1 = "Not at all likely", 7 = "Extremely likely"), and the strength of their intention to adopt them (1 = "Not at all strong", 7 = "Extremely strong"). Finally, the farms' locations in Italy, number of employees, and annual revenues were also assessed.

4. Results

4.1. Pilot Study Results

The data collected through the pilot study were content-analyzed to identify the behavioral, normative, and control beliefs underlying farmers' intentions to adopt water saving measures. Two research assistants repeatedly read respondents' answers and each of them proposed a list of concepts potentially useful for creating a coding scheme [61]. The assistants discussed each concept and modified their lists to converge on a common scheme that they used to codify all collected data. This analysis ultimately identified a set of beliefs that defined the variables of Ajzen's model (Table 1). Specifically, regarding the advantages of water saving measures (behavioral beliefs), respondents mentioned more frequently possible increments in productivity and reduction of irrigation water waste; on the contrary, as for the disadvantages of these practices, the majority of them thought that their adoption would require considerable financial investments. Respondents noted that several organizations could influence—one way or the other—the adoption of water saving measures, in particular, farm workers and environmental associations. As for the events and/or situations that could facilitate vs. hinder adoption, respondents most frequently mentioned financial incentives on the one hand, and on the other hand, the lack of experts that could help farmers to solve technical problems connected with the adoption of water saving measures.

Table 1. Farmers' behavioral, normative, and control beliefs.

Code	Behavioral Beliefs	N (%)	Code	Normative Beliefs	N (%)	Code	Control Beliefs	N (%)
	Advantages			**Adoption influencers**			**Facilitating events**	
ATT1	Productivity increments	32 (80%)	SN1	Farm workers	16 (40%)	PBC1	Financial incentives	28 (70%)
ATT2	Water waste reduction	30 (75%)	SN2	Environmental associations	16 (40%)	PBC2	Fiscal subsidies	10 (25%)
ATT3	Risk reduction of parasite infestation	6 (15%)	SN3	Public bodies	14 (35%)	PBC3	Provision of technical information	7 (17.5%)
			SN4	Trade unions	12 (30%)			
	Disadvantages						**Impeding events**	
ATT4	Large initial investments	30 (75%)				PBC4	Limited technical support	20 (50%)
ATT5	High maintenance costs	10 (25%)				PBC5	Rainy weather	9 (22.5%)
ATT6	Reduction of yields' quality	6 (15%)				PBC6	Equipment occupying too much land	9 (22.5%)

Notes: n = 40; ATT = Attitude; SN = Subjective norm; PBC = Perceived Behavioral Control.

4.2. Main Study Results

The data collected through the survey study served to implement our research model. First of all, for each farm, we calculated the average global WF, by considering its production mix and spatial localization. In particular, for each crop, as classified by the Harmonized System Code, we extracted data on the regional WFs in Italy [55,62], which take into account the production systems adopted in each region and hence capture differences in crops' production life-cycles. Then, by considering the weights of each crop in the production mix, we computed the average WF of each respondent farm.

Descriptive statistics were calculated for each item included in the questionnaire (Table 2). Each antecedent of intention encompassed by Ajzen's framework [11]—i.e., attitude, subjective norm, and perceived behavioral control—was modeled as a latent formative variable, whereas intention ($\alpha = 0.90$) and innovativeness ($\alpha = 0.85$) were modeled as latent reflective variables. For formative measures, the correlations among the items may assume both positive and negative values, and, as such, may not account for such measures' internal reliability (cf. [63,64]). For example, with regards to behavioral beliefs, it is possible to have two items that, albeit negatively related, can both serve to assess the latent construct (i.e., attitude). Conversely, for reflective measures, the items should be positively correlated and items' correlation accounts for such measures internal reliability.

Next, we tested the proposed model by fixing each parameter that links the observed variable to the latent construct at 1 and the measurement error variance at 0 and treated attitude, subjective norm, and perceived behavioral control as distinct formatively measured variables associated with a unique observed variable, that is, the item that measured each of these constructs in a direct way. We checked for multicollinearity problems (the presence of excessively inter-correlated constructs) which could undermine the correct evaluation of the relationships among variables [65,66]. Variance Inflation Factors (VIF) coefficients ranged from 1 to 1.3, and hence were lower than the commonly accepted threshold of 10 [66].

The Chi-Square/Degrees of freedom ratio was well below the recommended threshold of 3.0 [67], and the other fit indexes (Goodness of Fit Index (GFI), Comparative Fit Index (CFI), and Incremental Fit Index (IFI)) were close to the recommended threshold of 0.90 [68]. The Root Mean Square Error of Approximation (RMSEA) was below the threshold of 0.08, which indicates reasonable fit [69] (Table 3). However, following Diamontopulos and Siguaw's [70] suggestions, modification indexes were inspected in order to identify items with excessively high cross-loadings and improve the model fit. Eleven items (ATT2, ATT3, ATT4, ATT5, NS1, NS4, PBC1, PBC2, PBC4, PBC5, INN2) were eliminated, starting from that with the highest modification index. Fit statistics improved significantly (Table 3).

Table 2. Descriptive statistics.

Code	Item	M	SD
ATT1	Productivity increments	4.97	1.65
ATT2	Water waste reduction	6.49	1.05
ATT3	Risk reduction of parasite infestation	4.75	1.80
ATT4	Considerable initial investments *	3.30	1.68
ATT5	High maintenance costs *	4.05	1.64
ATT6	Reduction of yield's quality *	5.89	1.49
ATT	Direct measure of attitude **	5.72	1.25
SN1	Farms workers	4.15	1.91
SN2	Environmental associations	5.47	1.70
SN3	Public bodies	4.03	2.02
SN4	Trade unions	3.50	2.02
SN	Direct measure of subjective norm **	4.94	1.50
PBC1	Financial incentives	5.64	1.54
PBC2	Fiscal subsidies	5.48	1.69
PBC3	Provision of technical information	5.64	1.61
PBC4	Limited technical support *	3.20	1.79
PBC5	Rainy weather *	4.02	2.00
PBC6	Equipment occupying too much land *	3.51	1.93
PBC	Direct measure of perceived behavioral control **	4.59	1.42
INN1	Looking for ways to experiment with a new technology	5.01	1.38
INN2	Being the first to try out new technologies	4.54	1.54
INN3	Experimenting with new technologies	4.63	1.52
WF	Water consumption indicator	1181.13	1180.04
INT1	Intention strength	5.21	1.77
INT2	Likelihood of adopting water saving measures	4.95	1.85

Notes: * = Reversed items; ** = Direct items of Ajzen's antecedents of intention used to determine formative measures [11]. ATT = Attitude; SN = Subjective norm; PBC = Perceived Behavioral Control; INN = Innovativeness; WF = Water footprint; INT = Intention to adopt water saving measures.

Table 3. Fit statistics.

Fit Statistics	Initial Model	Purified Model
χ^2	426.6 ***	111.7 ***
Df	238	73
χ^2/df	1.79	1.53
Goodness of Fit Index (GFI)	0.827	0.907
Comparative Fit Index (CFI)	0.846	0.920
Incremental Fit Index (IFI)	0.854	0.923
Root Mean Square Error of Approximation (RMSEA)	0.073	0.060

Note: n = 150, *** = $p < 0.001$.

The results, summarized in Figure 2, show that attitude (β = 0.47, $p < 0.001$) and innovativeness (β = 0.17, $p < 0.01$) impact positively on farmers' intentions to adopt water saving measures; subjective norm has a marginally significant impact (β = 0.14, $p = 0.05$); whereas perceived behavioral control does not significantly affect intention (β = −0.05, $p = 0.51$). WF has a negative effect (β = −0.18, $p < 0.05$), which may derive from a biased perception of the amount of water required by their crops.

The results also showed that productivity increments (β = 0.25, $p < 0.01$) and reduction of yields' quality (β = 0.22, $p < 0.01$) had a significant and positive impact on attitude; Environmental associations (β = 0.27, $p < 0.01$) and public bodies (β = 0.28, $p < 0.01$) had a significant and positive impact on subjective norm; provision of technical information (β = 0.18, $p < 0.01$) and the belief that water saving would not occupy too much land (β = 0.23, $p < 0.01$) had a significant and positive impact on perceived behavioral control.

To further ensure the validity of the proposed model, we estimated an alternative, more complex model that included interaction terms between the examined independent variables. The analysis returned poor fit statistics for this alternative model (χ^2 = 662.46, d.f. = 22, $p < 0.001$; χ^2/d.f. = 30.112; GFI = 0.621; CFI = 0.574; IFI = 0.577; RMSEA = 0.442) and non-significant interaction effects, thus showing that our proposed model performed much better than such an alternative framework.

5. General Discussion

Uncontrolled and inefficient use of groundwater in agriculture is progressively increasing the risk of depletion of natural habitats and ecosystems and has brought water saving to the attention of researchers and policy-makers in many countries [1]. To identify the motivational factors that could drive farmers to adopt water saving measures, the present study embraced the well-known Ajzen's Theory of Planned Behavior [11], which in spite of its extensive use in the literature on pro-environmental behaviors (e.g., [71–73]), has rarely been employed to investigate the determinants of farmers' intentions to adopt water saving measures.

Consistent with previous research [29], this study established that farmers' favorable attitudes toward water saving measures predict their intention to adopt them. We found, in particular, that the possibility to benefit from productivity increments contributes to creating a favorable attitude towards water saving measures, whereas the risk of a reduction of yield quality seems to have an opposite effect. In line with Far and Moghaddam [30], subjective norm was proven to affect farmers' intention to adopt water saving measures, although to a marginally significant extent.

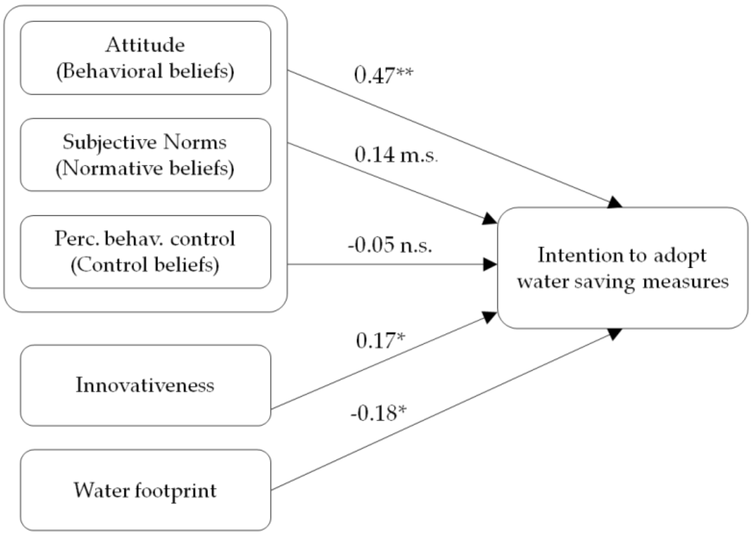

Figure 2. Path model results. Note: n = 150, ** = $p < 0.001$, * = $p < 0.05$, m.s. = marginally significant, n.s. = non-significant.

In particular, we found that environmental associations and public bodies are the organizations most likely to favorably influence farmers' adoption decisions. This finding reflects the fact that, in Italy, mainly in recent years, environmental associations have been taking on a prominent role in the environmental and sustainability debate, as a broad number of people are now concerned about the impact of farming on the natural environment (e.g., [35,74,75]).

In contrast to Yazdanpanah et al. [3], who found an influence of perceived behavioral control on Iranian farmers' adoption of water saving measures, this research did not ascertain a significant effect of this variable on Italian farmers' adoption intentions. A possible explanation of this finding is that in the past few years, national and regional policies aimed at leveraging the factors that we identified as events/situations that could facilitate the adoption of water saving measures, have had only modest results in Italy. Most importantly, this research detected a positive effect of farmers' innovativeness and a negative effect of WF on Italian farmers' intentions to adopt water saving measures.

From a practical perspective, our findings suggest that communication policies aimed at fostering farmers' adoption of water saving measures should mainly emphasize benefits in terms of productivity increments, to make farmers aware that water saving has no harmful effects on the quality of their yields. These policies could be coordinated by public authorities (in Italy, mainly the Ministry for

Environmental and Agricultural Policies) and environmental associations (e.g., Legambiente, WWF Italy, etc.). Such organizations could design and deliver messages appealing to farmers who have an innovative outlook and also attempt to stimulate innovativeness—for instance, through workshops and meetings on this topic area or even ad hoc training programs and/or projects with developers of farm innovations.

The negative impact of WF on farmers' intentions to adopt water saving measures suggests that farmers might be only partially aware of the pressure they exert on water resources and may be still anchored to a conventional perception of water absorption. In the past, blue water dominated the water consumption perceptions, although it represents only one-third of the "real" freshwater resource, namely rainfall [49]. However, the present study highlights that when analyzing agricultural production, it is important to consider both green water, which may constitute a potential productive stock for crop growth, and grey water, which serves to assimilate pollutants derived from human activities. It is also possible that the negative effect of the WF on farmers' intentions to adopt water saving measures may derive from farmers' perceptions of limited benefits in such measures when cultivations and/or production systems have WFs that are too high. In that case, in fact, farmers may think that changing the cultivation itself could be a more convenient option. Our study is novel in such an investigation of farmers' perceptions of the WF, as previous research devoted very limited attention to this topic [76,77]. As the amount of water required for adequate crop productivity depends not only on factors such as weather, soil characteristics, water quality, type of crop, but also on cultivation practices, increased farmer awareness of the WF would allow for more sustainable water management [78,79]. Hence, our results suggest that greater awareness and understanding of the WF concept, which represents a key-factor affecting water saving behaviors, could favor sustainable water consumption and management (cf. [80]).

6. Limitations and Future Research

This research features limitations that could be considered by future investigations. First, it is important to observe that the WF accounts for differences among agricultural production systems as it assesses the specific volumes of water demanded by crops, considers the territories where they are grown, and the diversity of farmers' production systems; indeed, by following the WF Assessment Manual [62], Mekonnen and Hoekstra [55] estimated the WF by taking into account crops' life cycles and by using data on crop production quantity, which is inevitably affected by production processes [19]. Nevertheless, because different production systems may pose peculiar constraints to the adoption of water saving measures (e.g., normative compliance, investment complexity, etc.), future studies are recommended to also investigate these factors to shed further light on the link between farmers' WFs and their adoption intentions; Second, we observed a low response rate as is typical of online surveys [81], and thus the results cannot be easily generalized to the whole population of Italian farms. Indeed, farmers who do not feel comfortable with providing data through online surveys [59] or are not familiar with online survey platforms [82], such as the older ones, might have been under-represented in our sample. To deal with these limitations, future research could incentivize potential participants or resort to other data-collection modes, such as paper-and-pencil questionnaires or face-to-face interviews; Third, all the surveyed farms were based in Italy, thus future studies could assess how the intention to adopt water saving measures changes across cultural contexts. Some cultures are indeed more tolerant towards new ideas in general, whereas others tend to be more conservative [83]; Finally, whereas this research considered commonly used water saving measures, future studies could focus, in particular, on water saving technologies and investigate the behavioral factors driving farmers to adopt such technologies.

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