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Review

Food for Hope: The Role of Personal Resources in Farmers' Adoption of Green Technology

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Abstract: Innovative technologies are expected to play a significant role in climate change mitigation and adaptation within the agriculture sector and in global food security. Clearly, however, the value of technological innovations in the agriculture sector is premised on their adoption. Therefore, understanding why farmers differ in their adoption of innovative green technologies is important. In the following paper, we review current literature and set the theoretical framework for suggesting that three important personal resources correlate with agricultural technology adoption: positive emotions, character strengths (including specific ones), and cognitive goal-oriented hope. This study constitutes an important theoretical basis for future practical recommendations for environmental policy, positive psychology, and innovation adoption that may help narrow some of the gaps in technology adoption rates. In addition to its theoretical innovation, the importance of this study lies in its practical value: we focus on variables that are influenced through policy, education, and communication. The theoretical connections between positive psychology and environmental studies emerging from this study should be developed and explored. We hope that this new perspective will motivate future research on these factors within diverse farming communities across different nations.

Keywords: green technology; technology adoption; agriculture development; character strengths; positive emotions; hope

Agriculture plays a central role in the discussion of climate change mitigation and adaptation for several reasons [1]. First, a large share of the world's population still relies on agriculture for income. Second, agriculture comprises one of the economic sectors most vulnerable to climate change [2]; and third, agriculture contributes to a negative impact on the environment and human health [3,4]. For instance, agriculture is a major contributor to greenhouse gas (GHG) emissions—especially in developing countries, where this sector accounts for an average of 35% of all GHG emissions [5].

Innovative technologies are expected to play a significant role in climate change mitigation and adaptation within the agriculture sector and food security [1,6–9]. In addressing climate change in particular, some of the most promising technologies can be categorized as "green innovative technologies": methods or materials that reduce negative environmental impacts. Clearly, however, a threshold condition for benefiting from the promises of innovative technologies is their utilization. Hence, the ultimate value of technological innovations is premised on their adoption.

Why do some farmers use green innovative technologies while others are reluctant to adopt them? Do adopters have different characteristics and personal resources than non-adopters? The present study proposes an innovative explanatory approach for answering these questions, which are key for adaptation and mitigation of climate change. Based on the theoretical premises of the innovative field of positive sustainability [10,11], we propose a pioneering set of explanatory factors that have not yet been considered in the scholarship.

A comprehensive literature review sets the theoretical grounds for suggesting that three important personal resources are correlated with technology adoption: positive emotions, character strengths

(including specific ones discussed below), and cognitive goal-oriented hope (heretofore, "hope"). Here, we consider these variables as applicable to farmers in particular. This theoretical model adds to the extant literature by seeking to fill in some of the gaps regarding adoption rates. Notably, by focusing on variables that are influenced through policy, education, and communication, we provide policymakers, industry, and academic labs with science-based tools for further promoting sustainable technology innovations adoption.

The paper is constructed as follows: we start by reviewing the extant literature regarding adoption of innovations, while highlighting the gaps in literature. We then turn to proposing our theoretical model regarding the role of the three personal resources in affecting technology adoption decisions and also highlight the interconnections among the variables. We conclude with policy recommendations and suggestions for further research.

1. Adoption of Innovation

Rogers and Shoemaker [12,13] define innovativeness as the degree to which an individual is relatively early to adopt an idea. Extant literature is dominated by three central basic models for explaining acceptance of innovations: (1) the Technology Acceptance Model (TAM) [14], which models how users come to accept and use a technology. The model proposes that when potential users are presented with an innovative technology, a number of factors affect their decision about adoption, especially: perceived usefulness and ease of use; (2) the Theory of Planned Behavior (TPB) [15], which links one's beliefs and behavior. The theory suggests that attitude toward behavior, perceived behavioral control, and subjective norms, shape behavioral intentions, and behaviors; and (3) the Unified Theory of Acceptance and Use of Technology (UTAUT) [16], which aims to explain user intentions to use an information technologies and subsequent usage behavior. The theory suggests four key constructs that affect adoption decision: performance expectancy, effort expectancy, social influence, and facilitating conditions. All three models were applied to assessing the causes of possible consumer acceptance specifically toward computers and information technologies. Moreover, most of the models focus on acceptance to consumers rather than farmers. Farmers are an essential group for climate change mitigation and adaptation and in global food security, and they face unique barriers for adoption [17]. Furthermore, none of these models refer to the role of personal resources in influencing green technology adoption decisions.

When examining specifically agricultural technological innovation, the majority of studies focus on adoption from an economic perspective, assuming economic rationality or efficient choice making [18–20] and emphasize the economic aspects and the social and geographic barriers that limit farmers' ability to adopt new technologies and practices (see e.g., [17,21–27]).

Yet economic, social, and geographic barriers fail to provide a comprehensive explanation for farmers' technology adoption, as even when these barriers are removed not all farmers adopt an innovation. Anecdotal evidence for the insufficiency of economic factors in explaining adoption or rejection of agricultural technologies is found in a variety of case studies [19]. For instance, empirical evidence from Kenya suggests that low rates of adoption are more often based on ignorance and lack of trust than they are on costs. Hence, even when farmers learn of the possible benefits of the technology, some lack trust that the novel technology will perform as it is alleged to [28]. Another factor affecting adoption rate involves farmers' culture [29] and attachment to current farming practices. For instance, in a study of energy crop producers, farmers' rating of their desire to continue their chosen lifestyle relates to the degree to which their identity is bound to it [30]. Likewise, attitudes toward risk and the extent of uncertainty involved in adoption of technology might affect adoption decisions (see a review of theoretical and empirical literature by [31]. Moreover, when studying dairy farmers in the EU Naspetti, et al. [32] described farmer's perceived usefulness of the technology as a key determinant of acceptance and intention to adopt the technology. A few studies describe primary adopters as self-sufficient, intuitive, and more tolerant of ambiguity (Rogers, 2003; Feaster, 1968). Furthermore, adoption of some agricultural methods such as organic farming and the cultivation of genetically

engineered crops also requires a new set of skills, making it possible only for those capable of and interested in acquiring them. Theoretical modelling and empirical evidence suggest, moreover, that the rejection of efficient innovations may also be connected to the adopter's social context (including peer imitation practices) as well as to powerful external influences [19,30,32]. Finally, some farmers seem to be willing to forego profits to adopt conservation practices [33], thus pointing to an ideological feature in this decision-making process as well.

Many studies suggest tailoring policy to accommodate personal behavioral factors (see, e.g., [17,19,28,30]). Yet the empirical literature on the adopters themselves is scant [34,35], and much remains unknown about technological adoption by farmers. Some studies even suggest that the existent research on agriculture technology adoption is ineffective, given its lack of innovative research methodologies and a holistic, robust, interdisciplinary perspective [36,37]. Moreover, Marra, Pannell and Ghadim [31] posit that personal behavioral indicators often have been blurred or treated incompletely in past research.

Given the gap in the current literature and the lack of a comprehensive analysis of factors affecting decision-making processes regarding adoption of technology, we proceed to propose our theoretical analysis of important missing components in the understanding of innovation adoption by farmers. We follow the theoretical construct of Kahneman and Tversky [38], showing that decision making—especially under risk—involves one's personal perspective of the options. Emotions and thoughts motivate all types of behavior, including rational decision making [39,40]. Yet, most studies of innovative technology adoption by farmers do not consider personality elements in explaining the adoption decisions. Below, we explain why the theory on technology adoption could benefit substantially from including personal resource aspects, which remain generally overlooked in the adoption research and have not yet been studied specifically as explanatory factors for agricultural innovation adoption. We proceed to explain the significant potential of a focus on the adopter, taking into account personal resources (positive emotions, character strengths, and hope)—which the extant research has overlooked. In contrast to socio-economic factors, which usually remain constant and difficult to change, we suggest a focus on malleable factors that may be influenced through policy tools and education; therein rests the promise of this approach.

2. Positive Emotions

Positive emotions include pleasant or desirable situational responses, ranging from interest and contentment to love and joy. These emotions are markers of people's overall well-being or happiness, but they also enhance future growth and success [41]. The theories of emotions that dominated psychology for most of its history proved fruitful for studying negative emotions but were often a poor fit for positive emotions [42]. However, in recent years, positive emotions have come into their own [41], and there are a few popular measures used to quantify to quantify them, such as the Positive and Negative Affect Schedule (PANAS), which is a self-report questionnaire that consists of two scales to measure both negative and positive affect [43], or the Affect Grid, which is a moderately valid single-item scale of pleasure and arousal [44].

Theoretical grounds for assuming that positive emotions influence the decision to adopt a technological innovation take root in Fredrickson's broaden-and-build theory of positive emotions [45]. Four aspects of the broaden and build theory are specifically relevant for the adoption of innovative green technology. First, positive emotions "open people up", making them more resilient, creative, and open to changes and new experiences [42]. Such openness is critical since adopting innovative agricultural technologies requires motivation and a decision to undertake this change [15,35,46].

Second, as per Fredrickson's broaden-and-build theory, positive emotions may affect the building of an individual's intellectual and social resources [42]. Intellectual resources are needed to fully understand the needs for innovation and its perceived effects, whereas social resources have been found to affect (positively or negatively) adoption decisions and perceptions of the innovation [19,30]. Hence, we hypothesize that positive emotions may influence farmers' establishment of intellectual

and social resources that have been found to affect adoption [19,30–32], thus potentially increasing their likelihood of adopting innovative technologies.

Third, positive emotions have been shown to influence decision-making. As noted above, Fredrickson hypothesized that positive emotions make people more resilient, creative, and open to changes and new experiences [42]. Indeed, further research found positive emotions to profoundly affect cognitive processes, judgment, economic transactions, and decision-making [47,48]. Isen and Means [49] offer empirical evidence to suggest that people in a good mood are more efficient decision makers than those in a bad mood. Positive affect is also empirically associated with increased risk taking when the level of risk is understood [50]. The adoption of agricultural technology often involves a high level of uncertainty, and people feeling positive emotions might be more willing to undertake these risks. Positive emotions may also increase adoption of innovation since they increase attention levels [51] and facilitate creative problem solving and learning [42,52]. Thus, farmers who experience more positive emotions are expected to adopt new technologies as a way of solving a personal or global problem that is brought to their attention.

Forth, emotions are specifically involved in the evaluation and adoption of innovation. In an empirical study, Wood and Moreau [53] showed that positive emotions predicted positive evaluation of an innovation before its use. They suggest that, before using the innovation, any threats to expected goals were only hypothetical, which possibly means that the negative emotions generated before the use were not substantial enough to influence evaluations. Choi, et al. [54] highlight the important role of emotions in the context of innovation adoption within an organization. They suggest that overall positive emotions toward an innovation are positively related to the effectiveness of its implementation. Specifically, perceived usefulness has been shown as a key determinant of acceptance of agricultural innovation, and the intention to adopt it [32].

Finally, in the environmental context, several papers suggest a correlation between subjective wellbeing and environmental behavior [55–57]. In addition, a recent study by Junot, et al. [58] showed empirically that by promoting open-mindedness, positive emotions are positively related to environmental behaviors. As adopting a green technology involves using a technology that harms the environment as little as possible, or even benefits it, it may be considered as a form of environmental behavior [59] and even, pro-environmental behavior as defined by Steg and Vlek [60].

Following the empirical evidence regarding the influence of positive emotions on decision-making processes, intellectual resources, evaluation of the adoption and openness to new experiences, in addition to the initial evidence regarding the connection between positive emotions and environmental behavior, we hypothesize that positive emotions will be positively correlated with farmers' decisions to adopt green innovative technologies.

3. Character Strengths

Character strengths comprise an additional personal resource that may influence the decision to adopt a technological innovation. Peterson and Seligman [61] define character strengths as capacities people have for feeling, thinking, and behaving in ways that benefit others and themselves. While all people possess all 24 character strengths that Peterson and Seligman [61] define (e.g., creativity, curiosity, bravery, fairness, self-regulation, and judgment), each person is unique in using a specific set of strengths. Hence, the overall use of strengths differs. Character strengths are measured using the VIA Survey [61].

Based on the theory, we hypothesize that specific character strengths might be more connected to adopting technology. For example, creative people have the capacity to solve problems in innovative ways; since the two key components of creativity are originality and adaptiveness, creative people tend to be unsatisfied with behaving the conventional way if they perceive a better option [61]. Feist [62] described creative people as possessing a unique set of traits. Specifically, they tend to be independent, nonconformist, unconventional, and they are likely to have greater openness to new experiences, cognitive flexibility, and risk-taking boldness. More recently, Zenasni et al. [63] showed empirically

that tolerance for ambiguity and creativity are interrelated moderately and positively. Similarly, higher levels of general creativity empirically predict higher levels of cognitive risk tolerance [64]. Furthermore, based on the definitions of creativity, which includes tolerance for uncertainty and constantly seeking innovations as solutions and improvements, we hypothesize that faced with the challenges of climate change [2] or food security [1], creative farmers are more likely to adopt innovative green technologies.

In addition, curious people recognize, search, and wish to explore innovation. Curiosity plays a role in seeking out both knowledge and new experiences and activities [61]. Kashdan et al. [65] suggest that curious people are more motivated to seek knowledge and new experiences, and that curiosity plays a part in people's willingness to embrace the novel and unpredictable nature of life [65]. He et al. [66] posit that the intrinsic satisfactions of curiosity and interest lead to exploration and to taking on challenges such as sustainable behavior. We propose that curious people will tend to adopt technology for three main reasons that are connected to the core definition of curiosity. First, innovations could provide them continually with complex and changing material to sustain their curiosity and interest. Second, by seeking knowledge, they are more likely to gain the skills needed for adopting and using the agricultural technologies. As adopting agricultural technology is usually accompanied by uncertainty [17], curious people's willingness to embrace uncertainty should support their decision to adopt it.

Finally, persistent people act with tenacity until they have achieved their goal, despite challenges and difficulties [67]. Based on empirical evidence, Pury and Kowalski [68] suggest that persistence is a main component of courageous actions and of overcoming fear. Persistent farmers are expected to overcome bad experiences on the farm and to keep trying new ways to succeed. As this strength is associated with courage, we believe that farmers demonstrating persistence are more likely to take the inventive risk of adoption in the first place.

More generally, Corral-Verdugo et al. [69] find a strong correlation between the cumulative measure of all character strengths and the cumulative measure of all types of sustainable behavior. While innovation adoption is not completely parallel to sustainable behavior, it may be considered so in cases where technology adoption is based on concerns for the future and environmental considerations.

4. Hope

Lastly, hope is a feature intertwined with the potential to influence adoption decisions. Our definition of hope follows the three components of Snyder's hope theory [70]: (1) having goals about what one wants to happen, (2) pathway thinking, or the ability to come up with ways to get where one wants, and (3) agency thinking or the motivation to use these pathways. This factor can be measured using the adult hope scale (AHS), also known as the goals scale [71]. In addition to positive emotions and character strengths, hopefulness as defined by Snyder [70] can affect the perception of technology and the ultimate adoption decision. Indeed, hope has been found to comprise an important variable connected to motivation, action-taking, and problem solving [70–74].

People feeling a high degree of hope tend to take action and have the capacity to work out ways to reach their anticipated goals [70]. Hope is specifically needed in order to take action in situations where one believes the chances for success to be limited [72]. In some cases, moreover, hope has been known to mediate the negative potential of fear [73]. In health psychology, studies show that people with high levels of hope have a better ability for constructive thinking about how to deal with their problems [74].

The behavioral outcomes of hope from empirical research in different contexts indicate the likelihood of two main theoretical influences on the behavior of farmers while making decisions of whether or not to adopt a technological innovation. First, empirical evidence suggests that farmers' decision to adopt innovative technology is related to its anticipated desired impacts (e.g., perceived usefulness, profit, farm performance) [13,15,32,46]. Studies suggest that the level of personal hope spurs anticipation of a better future; thus, more hopeful farmers would be encouraged to set more

complicated goals and take actions [70–72]. Hence, we suggest that farmers' levels of hope influence their decision to adopt a new technology due to its perceived desired impacts. More hopeful farmers are expected to anticipate that the technology will improve their lives and thus decide to adopt the technology based on a better anticipatory future. Moreover, the consequences of global climate change as a background factor in adopting technologies, alongside the need for adaptation, presents farmers with uncertainty risks [17] and may result in fear. Hope has been shown to manage the negative effect of fear. Farmers with higher levels of hope are expected to better deal with fear of risks. The emotion management process could either foster alternative feelings, or in cases of non-acute fear, fear might supply the capacity to initiate action against the upcoming threat when mediated by hope [73]. Hence, hopeful farmers could decide to adopt the technology by overcoming fear or by utilizing fear as part of their motivation to act.

Empirical evidence supports the theoretical reasons to assume a connection between farmers' hopefulness and their decisions to adopt innovative technologies. In order to increase adoption rates in Kenya, Eidt, Hickey, and Curtis [28] suggest to boost farmers' trust that the technology will accomplish its professed aims and that if problems arise, some plan exists to correct or alleviate the problems. These scholars' suggestions correspond with Snyder's hope theory; they found empirically that improving agency thinking (the belief or trust that the technology will deliver its promised outcomes) and pathway thinking (understanding the different paths to achieve the goal should one path fail) leads to higher adoption rates. Hence, we hypothesize that farmers' levels of hopefulness positively correlate with their adoption of innovations.

In addition to its general potential to affect adoption of innovation, hope was found to be correlated with environmental behavior in several cases: Kleres and Wettergren [73] suggest that hope influences environmental actions and encourages climate activism, while (collective) action generates hope and manages fear. Ojala [75] found hope to comprise an important and unique cognitive factor in promoting environmental behavior. Kerret, Orkibi, and Ronen [10] found that the level of hope explains the relation between the influence of environmental education and environmental behavior. These studies suggest that in situations of low certainty and high levels of fear regarding the future, hope influences the decision to pursue environmental behavior. As mentioned above, the adoption of some technologies involves a pro-environmental attitude, so the positive correlation of hope with environmental behavior strengthens the argument that the level of hope should be positively correlated with adoption.

5. Discussion

Most studies of technological innovation adoption focus on socio-economic explanatory factors, providing only partial explanations and leaving many dynamics unexplained and unaccounted for. Despite attempts to understand the necessary conditions for successful environmental innovation implementation policy, much remains unknown or under debate. As people are not passive recipients of innovations, we suggest that farmer's personal resources can potentially affect the adoption process. This innovative set of explanatory factors has not yet been considered in literature. As such, this study constitutes an important theoretical basis for future practical recommendations for environmental policy, positive psychology, and innovation adoption.

To sum up the forgoing theoretical analysis, our proposed psychological mechanisms underlying farmers' decisions to adopt green innovative technology suggest a focus on three personal resources variables. Based on literature regarding consumer behavior, risk perception, and environmental behavior, we suggest that positive emotions may positively affect farmers' decision to adopt green innovative technologies mainly due to improved decision-making processes. Farmers with higher levels of hopefulness will tend to engage more in green innovation adoption, mainly due to higher motivation and tendency to take an action, alongside their higher likelihood to pursue environmental behavior. In addition, farmers exhibiting high levels of particular character strengths will engage more in green innovation adoption, comprising environmental behavior.

It is important to note that positive emotions, character strengths, and hope are all connected and might affect each other. For example, positive emotions are correlated with the level of creativity [52]. Grateful and curious individuals experience more positive emotions [65,76]. Positive affect relates positively to creativity in organizations [77]. Both cognitive hope and character strengths increase subjective well-being (SWB) [78–83]. As positive affect is an independent measure for SWB, clearly it should be correlated with character strength and hope [84]. Although all three indicators positively interact, each has its own unique theoretical contribution to adoption processes. Future empirical research should investigate the specific interconnections among all variables and technology adoption.

Furthermore, we argue that interventions could reinforce hope, positive emotions and character strengths (as per [81,85–87]). When such interventions are targeted at decision-makers in the agricultural sector, they could result in substantial changes. Empirical research is needed to determine exactly the type of interventions that should be included to encourage technology adoption. Quantifying the contribution of personal resources to the adoption process will enable the generation of more precise, practical recommendations. Based on the theoretical premises in this paper, development organizations, government agencies, and trainers might benefit from acknowledging farmers' personal resources and trying to utilize them to promote environmental technology adoption. In such cases, beyond a mere focus on farming techniques and economic abilities, engagement with farmers and the establishment of training programs and demo farms should be undertaken with the aim of boosting hope, promoting positive emotions, and addressing character strengths. Moreover, policy programs may attempt to actively promote farmers' sense of hope for their future and the future of the planet. Future research might also attempt to determine how personal resources, such as hope, character strengths and positive emotions, relate to an overall safe economic environment, which promotes investments and risk taking (such environment is measured for example using the Global Green Economy Index [88] or the Index of Economic Freedom [89]).

The main contribution of this paper involves its introduction of the concept of personal resources' influence on technology adoption within the agricultural sector. We hope that this new perspective will motivate future empirical research to test this theoretical model within diverse farming communities across different nations. Most importantly, researchers should assess the extent to which current green innovation policy programs elicit fear, anger, guilt, or shame compared with the extent to which these programs promote farmers' perceptions of their own agency to render environmental change, their ability to generate workable routes for achieving environmental goals, and their trust in potential pro-environmental social partners. Finally, the theoretical connections between positive psychology and environmental studies should further be developed and explored in future local and international empirical research. Adoption of green agriculture technologies offers a promise for a sustainable future; as such, assisting such adoption should comprise a priority for scholars and policymakers alike.

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