

# ***Technology adoption in agriculture: a new entrepreneurial approach is possible?***

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## **Abstract**

Technological propensity of agricultural entrepreneurs is becoming necessary to identify and explore new opportunities. Recent studies suggest that the adoption of new technologies is strictly coherent with wider approaches of Entrepreneurial Orientation (EO). Even if the relevance of agriculture is increasing, entrepreneurial research has largely overlooked this challenging sector. Moreover, there is a relative shortage of empirical studies in the literature and there is an enormous potential to be still explored. Stemming from the EO literature, the work proposes for the agricultural sector, the approach of Humane Entrepreneurial Orientation (HEO). The paper proposes an empirical analysis, to verify the effect of the different dimensions of HEO on the propensity of farmers to adopt new technologies. All the results highlight several implications for businesses, for the research system and for public policies.

*Keywords:* Technology adoption, human entrepreneurship, agricultural sector, propensity to innovate.

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## **Introduction**

The need of agricultural firms to adapt to new challenges, such as changes in the market, and in consumer behaviors is increasing the attention of scholars regarding *entrepreneurship in agriculture* (Seunke et al. 2013; Lans et al. 2017). The entrepreneurial activity of farmers, in fact, is becoming essential to face the complex environment in which they operate and farmers are considered as entrepreneurs within a rural setting (McElwee 2006, 2008). Farmers have been looking for new strategies to respond to this new scenario (Alsos et al. 2011; Bond and Graff 2012; Rangone 2019). Some authors have stated that in this new dynamic context, agricultural activities need to provide entrepreneurial opportunities such as the development of new products and the implementation of new business processes (Pindado & Sánchez 2017). In the last years, the application of new high technology in agriculture is significantly increasing (Cavallo et al. 2014), technological propensity of agricultural entrepreneurs is becoming crucial to the identification and exploration of new opportunities. Following this perspective, a recent study of Dias et al. (2019) highlights the importance of Entrepreneurial Orientation (EO) in agriculture. It is a strategic that represent a very interesting issue in the entrepreneurial literature (Rauch et al. 2009), even if there are still few studies in the agricultural sector. Some studies in the entrepreneurial field, highlight that is necessary to understand how EO can lead firms' change (Veidal &

Flaten 2014), by suggesting concentrating future research on the strategic posture of farmers. Despite agriculture sector is very different from other sectors, like manufacture and high technology farmers can be considered as entrepreneurs (Vermeire 2009). Consequently, according to the recent work of Dias et al. (2019), agricultural entrepreneurship can be analyzed by applying the approaches already used in all the other sectors. Taking the international trends, Agriculture lies at the very heart of the 2030 Agenda for Sustainable; moreover, FAO's report (2017, p.7) maintains that "*Major transformations of agricultural systems, rural economies and natural resource management will be needed, if we are to meet the multiple challenges before us and realize the full potential of food and agriculture to ensure a secure and healthy future for all people and the entire planet*". Thus, the "humane" perspective it is no longer a mainly business model decision but is becoming a fundamentally inspired process for entrepreneurs. Thus, coherently with these international perspectives, we propose a new entrepreneurial posture for the agricultural sector, that is: *Humane Entrepreneurship Orientation* (Bae et al. 2018; Kim et al. 2018; Parente et al. 2018; Parente et al. 2020). It is a new model of entrepreneurship in which the attention that firms have traditionally paid to business is integrated with care for firm members, the planet, and society at large. This approach, in fact, appears to be the most appropriate for agricultural sector. The paper proposes an empirical analysis, with the aim to verify the effect of the different dimensions of HEO (Entrepreneurial Orientation (EO), Sustainable Orientation (SO), and Human Resource Orientation (HRO)) on the propensity of farmers to adopt new technologies. Specifically, a mixed qualitative and quantitative approach is proposed. First, a thematic analysis approach (TA) is applied, followed by an explorative factor analysis based on Principal Components Analysis (PCA). Then, a regression model is proposed. The paper is organized as follows: first, we explore the critical factors highlighted by the literature on entrepreneurship and technology adoption in agricultural, then we develop an empirical investigation, by emphasizing the main results. Conclusions and implications are drawn from the findings.

### ***Technology Adoption and Entrepreneurial Orientation (EO) in Agriculture***

The application of key enabling technologies (KET) is considered the frontiers for innovation in agricultural sector (Galloway & Mochrie 2005). Farming decisions imply innovation development by the adoption of new technologies, such as: automation, animal and vegetal breeding, pasture management (Jung et al. 2011; Morris et al. 2017; Song et al. 2020). The process of adopting technological innovations, in fact, is becoming a necessary path, also in agriculture, where it is influenced by a wide range of drivers. Considering that there is a significant increasing of high technology application in agriculture (Cavallo et al. 2014), the technological propensity of agricultural entrepreneurs is becoming necessary to identify and explore new opportunities (Kohli & Tiwari 2016). Recent studies (Morris et al. 2017; Bandera et al. 2020), in fact, suggest that the adoption of new technologies is strictly coherent with wider approaches of EO. The EO explains how "being entrepreneurial" in organizations or in their business units (Basso et al. 2009; Covin & Slevin 1989, 1991; Covin & Wales 2011). According to Covin and Wales (2011), the roots of EO research can be found in the work of Mintzberg (1973) who considered an entrepreneurial strategy-making mode as a managerial behaviour *characterized by the active search for new opportunities in uncertain environments*, through which dramatic changes might be implemented. Entrepreneurial orientation (EO) was a concept revised by Miller (1983) which proposed three main dimensions, namely: innovativeness, pro-activeness and risk-taking. Also Covin and Slevin (1989) studied the construct by proposing the concept of entrepreneurial strategic posture (ESP). Lumpkin and Dess (1996) refined the concept of EO, by

suggesting a new model with five-dimensions: autonomy, innovativeness, risk-taking, pro-activeness and competitive aggressiveness. Also other researchers have been articulated EO as a firm-level construct, that *determines* firms' performance (Gupta & Gupta 2015). Recent works suggest that the two principal conceptualizations (explained above) of EO, can co-exist in the literature (Covin & Lumpkin 2011; Miller 2011; Covin & Wales 2012). Following the mainstream of the entrepreneurial literature, different studies focus on the agricultural firms (Mirzaei et al. 2016), Some investigations show that proactivity and risk-taking influence technology adoption (Perez-Luño et al. 2010), while other studies argue that the agricultural entrepreneur faces a great deal of uncertainty due to the uncertainty of agricultural markets. The agricultural entrepreneurs seem to adapt to new challenges by implementing technology change (Lanza & Passarelli 2014; Pindado & Sánchez 2017) by considering the impact on the environment (Britz et al. 2012; Pindado & Sánchez 2017). The sustainability issue, in fact, must be extended to farms with only agricultural businesses (Barbieri 2013). Moreover, entrepreneurs in agricultural sector have the aim to generate value added in rural businesses, that requires a switch from agriculture's traditional "core" activities to new activities that include process and/or product innovations (Lussier & Corman 1995). In this framework, Dias et al (2019) show also that personal features of entrepreneurs. Thus, the propensity of agricultural entrepreneurs to adopt new technologies, is becoming essential issue in the EO process (Cavallo et al. 2019), by considering the internal and external "human aspect" related both to employees and to external owner of tacit knowledge and technologies (Zaika & Gridin 2020). Farmers are asked to develop suitable "strategic posture" to adopt new technologies, that remain a critical topic for agricultural development (Federe et al. 1985; Feder & Umali 1993; McFadden & Gorman 2016). Agriculture is among the world's largest sectors, employing over one billion people and accounting for 3% of global GDP (FAO 2017). Even if the international relevance of this sector is increasing, the entrepreneurial literature has largely overlooked this challenging sector. Moreover, there is a relative shortage of empirical studies in the literature (Dung et al. 2020) and there is an enormous potential to be still explored and also farmers can be considered as entrepreneurs (Vermeire 2009). Consequently, agricultural entrepreneurship can be analysed through new approaches and theories used in non-agricultural sectors (Mcelwee 2006). Thus, we attempt to contribute the literature on agriculture entrepreneurship, by applying to this specific sector the frontier of the extensive literature on EO; in fact, we propose a new approach that is emerging in the entrepreneurial literature (Kim et al. 2018; Parente et al. 2018): the **humane entrepreneurial orientation (HEO)**. It is based on three main dimensions: *Entrepreneurial Orientation (EO)*, *Sustainable Orientation (SO)*, and *Human Resource Orientation (HRO)*. At the same time, we offer to the literature on humane entrepreneurial orientation, an empirical application by exploring the main factors underlying the technology adoption. The research question is the following: *how humane entrepreneurial orientation (HEO) impact on technology adoption in agriculture?*

### ***Research Design and Methodology***

In this context, we attempt to verify the effect of apply *Human Entrepreneurial Orientation* posture on the intention of adopting new technologies in the agricultural sector. For the empirical analysis, we used a **mixed qualitative and quantitative approach**. We started with an *explorative qualitative analysis*; specifically, we conducted some structured interviews to investigate the main factors that lead entrepreneurs in agriculture sector, to adopt new technologies. All the

data gathered from the interview were grouped by using a *thematic analysis approach* (TA) by following Castleberry and Nolen (2018). Once we got the main specific factors that lead entrepreneurial intention to adopt new technologies, we started a *quantitative analysis*. Specifically, we created a survey that we proposed to a large sample of agricultural sector. Data from survey were analysed by using factor analysis, that is a statistical method used to decrease data to a smaller set of summary variables and to investigate the fundamental theoretical structure of the phenomena (Tufféry 2011). This technique extracts maximum common variance from all variables and puts them into a common score. Therefore, it allows to reduce the “dimensions” of our data into one or more variables. Specifically, we applied the *Principal Component Analysis (PCA)*. Finally, we tested the relation between the variable from the PCA and the intention to adopt new technologies, by proposing a *regression model*.

### ***Explorative Qualitative Analysis***

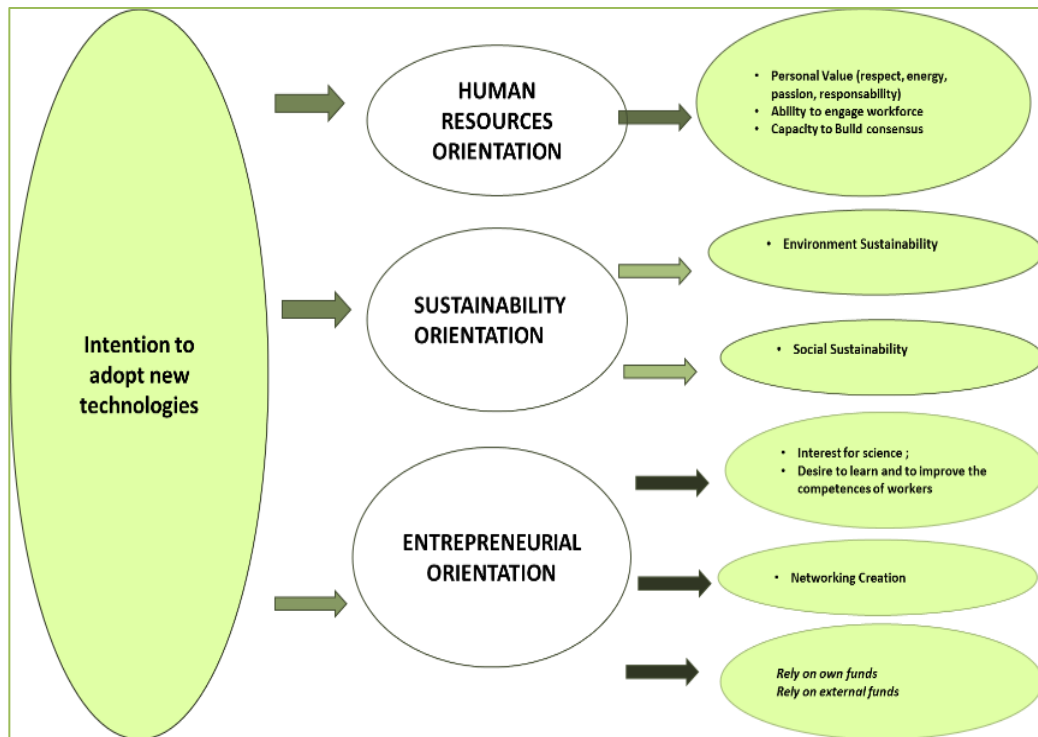
#### ***Data Collection***

In January 2020 we launched a call for experts on LinkedIn, to involve a panel of experts in our explorative study. The experts were required to have some specific characteristics: they were required to be innovation managers, researchers or entrepreneurs in agricultural sector, with at least 5 years of experience. We closed the call at the end of March 2020. We got the availability from seven experts: four Italian entrepreneurs operating in the sector of agriculture, with a long technology transfer international experience; one technology transfer expert working in an Italian University; two innovation brokers working in agriculture associations. In April 2020 (lockdown period due to Covid-19), we carried out semi-structured interviews, by using Skype. The interviews lasted between 60 and 120 minutes to investigate which are the main drivers of EO that encourage the adoption of new technologies in the agriculture sector (Appendix A). Stemming from the mainstream of EO literature, the interviewers proposed different possible practices as the most suitable to explain technology adoption. Since in the qualitative research reflexivity is a crucial issue throughout all phases of the research process, one goal is to monitor the reflexivity effects. To enhance both the accuracy of the research and “the credibility of the findings by accounting for researcher values, beliefs, knowledge, and biases” (Cutcliffe 2003) and research’s trustworthiness (Buckner 2005), we involved an external interviewer. Moreover, we compared the analysis of the content by all the researchers involved in the paper.

#### ***Data Analysis***

We cluster the data from interview by using a *thematic analysis approach* (TA) by following Castleberry and Nolen (2018). It is a method of identifying, analysing, and reporting themes within data. TA of open-ended answers, from survey or transcribed interviews, allowed us to explore the context of technology adoption at a level of profundity that quantitative analysis lacks, while allowing flexibility and understanding when analysing the data; it should be used with special care and attention to transparency of the method in order to ensure confidence in the findings. After the transcription of interviews, in fact, we assigned specific codes to our data, where a code is a brief description of what is being said in the interview. We used Excel for coding the notes on a printed transcript. Then, we reviewed and refined the themes that we identified before. We read through all the extracts related to the codes to explore if they support the theme if there are contradictions and to see if themes overlap. Then, keeping in mind the *Hum*

an *Entrepreneurial Posture*, we attempted to collect the answer in 3 main pillars, that, coherently with the basic components proposed by Parente et al. (2018), we named: *Humane Resources Orientation*, *Sustainability Orientation*, *Entrepreneurial Orientation*



Source: authors' elaboration

Figure 1. The items from the Thematic Cluster Analysis (TA)

#### Cluster 1: Humane Resources Orientation

An important element that came out from the interview is the human capital: "We live in a developing region, where very few firms are high technology firms. In our context human resources are crucial for firms' growth. It is important our ability to build consensus among our workers by generate a communicative business culture, by involving workers in the innovation activities, by creating an environment where each employee is encouraged to develop new skills and to enhance knowledge". (Entrepreneur). The interviewed gave a special emphasis to four main key factors, already proposed by Kim et al. (2018, p. 21): equity, empathy, enablement and empowerment. Specifically: "Equity is the extent to which a company treats individuals in a fair and equal manner. Empathy is a key factor for employee engagement and a communicative business culture, leading to better comprehension between organizational members and stakeholders. Empowerment is the delegation of power and responsibility from higher levels of the organizational hierarchy to lower levels, especially in regard to an employee's ability to make decisions; Enablement is the extent to which a company provides the environment where each individual employee is able to develop skills and knowledge, consisting of both skill and infrastructure". In fact, when workers feel in an "harmonic relation" with the entrepreneurs, they feel free to propose technological needs, to generate new ideas that encourage the entrepreneur to exploit new

*opportunity* (Graskemper et al. 2021). Coherently with Parente et al. (2018), companies generate higher profits by respecting employees and encouraging them to enjoy their work. From the interviews, comes out that human factors are crucial for technology adoption. Consequently, the following hypothesis comes out: *Hp1: Human resources orientation has a positive impact on the intention to adopt new technologies.*

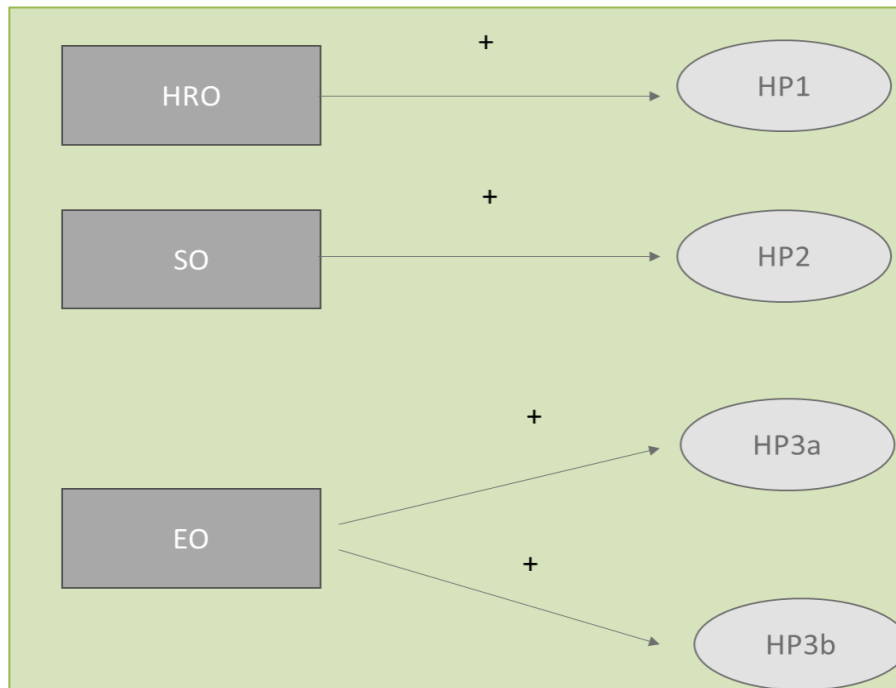
### **Cluster 2: Sustainability Orientation (SO)**

*Agricultural technology brings about so many improvements to the world of agriculture, which without the world of today won't survive." The use of these new technologies will allow us to decrease the use of water, but also of pesticides, which in turn maintains food prices down. New technologies will reduce the runoff of chemicals into rivers and groundwater. Moreover, entrepreneurs desire to introduce new technologies also to be sure that also the worker safety will increase".* (Innovation broker). The estimate of the economic benefits represents a preliminary aspect relevant for technology adoption. Environmental Sustainability is another crucial factor in agriculture since it represents the latent attitudes to protect the planet and to promote social responsibility (Afshar Jahanshahi et. al. 2017). In the vein of entrepreneurs, in fact, technologies help the improvement of social wealth and the satisfaction of social needs (Ruskin et al., 2016): *"Most of the farmer needs our help to introduce sophisticated technologies in their processes, such as robots, sensors, GPS, biotechnologies, etc. These can generate innovations that can allow businesses to be more profitable, efficient, safer, and environmentally friendly"* (Innovation broker). Then, interviewed experts highlighted elements that can be related to **Sustainability Orientation (SO)** (Parente et al. 2020), thus: *Hp2: Sustainable Orientation (SO) (Environmental, Economic and Social) has a positive impacts on the intention to adopt a new technology*

### **Cluster 3: Risk taking, proactiveness and innovation**

This cluster relies on the approach of Tang et al. (2008), that uses two of the dimensions (risk taking and proactiveness) to predict the nature of the third dimension (innovation adoption) (Gellynck et al. 2015). From the interviewed it comes out that while the entrepreneur can himself set the tone for risk taking, other competences must be complemented by external skills to boost innovation. *"We think that technology adoption is becoming crucial for our firms, however, most of the time we lack knowledge and technologies; then, we need to create relations with external actors in order to provide outside resources able to growth, otherwise, we have to give up! To introduce new technology, we need to create relations with universities, research centers or other firms. This is a challenge for us"* (Entrepreneur). Following this perspective, when firms lack core knowledge and skills to lead innovation, they can develop **Proactiveness**. In our perspective, **proactiveness** means to develop Network and Ecosystem Development (Parente et al. 2018), in order to exploit new opportunities. Then, an open and proactive approach is required: *"When we explain to entrepreneurs the advantages to create relations with our university, to implement innovations, they start to be positive and they start to call us every day"* (Technology Transfer Expert). From this network viewpoint, EO appears to be a strategic posture, that encourages firms to proactively build relationships with different actors (Jiang et al. 2018). The experts highlighted that firms with a high EO have a good possibility to scout external technologies and consequently, to exploit them. Moreover, from the interviews came out that entrepreneurs consider the external financial support as needful factor, to catch new opportunities: *"At the beginning of our activity we felt anxious to invest our own resources, thus we mainly relied on external financial support (public and private). Now, we feel more assured and we can take the risk to*

*adopt new technology by using our own money”*(Entrepreneur). Risk taking is a firm’s propensity to dedicate resource s to risky projects with the aim to gain superior returns (Lumpkin & Dess 1996). As we already said, we rely on the EO li terature to hypothesize that risk taking and proactiveness predict innovation and technology adoption for innovation i n different ways. Consequently: *Hp3a: Proactiveness have a positive impact on the intention to adopt new technologie s to create innovation* and *Hp3b. Risk taking have a positive impact on the intention to adopt new technologies*. All the hypotheses are illustrated in the Figure 2 below:



**Figure 2. Main Hypotheses**

*Source: authors' elaboration*

The findings of the qualitative analysis formed the basis for developing a quantitative analysis and carrying out an empirical verification in which the previously identified hypotheses were tested. The process described above is shown in the following picture.

### Quantitative analysis

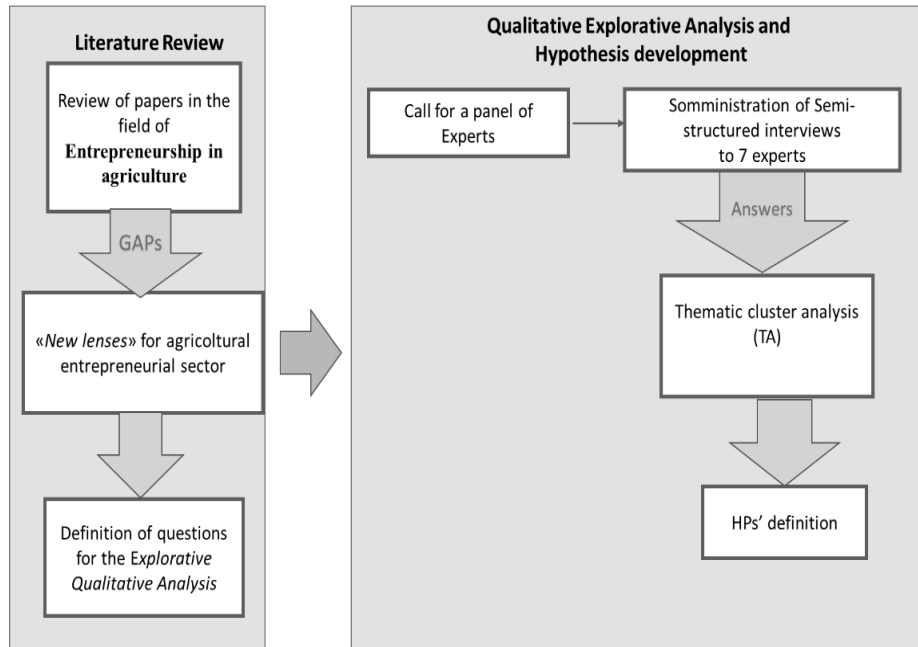
Starting from TA, we developed a quantitative analysis. Since the technology adoption is a phenomenon strongly observed during the Covid period, it was a good opportunity to get a better awareness of the object of study.

Specifically, starting results of the *Thematic Cluster Analysis*, we created a survey, by using the metrics proposed by the literature on Human Entrepreneurship. To measure **Humane Resources Orientation** we adopt the approach of Kim et al. (2018, p. 21), suggested also by Parente (2020, p.17).

To measure **Sustainable Orientation** (environmental, social and economic), we consider the individual level (Kuckertz & Wagner 2010), essentially concentrate on individuals, who take care of environmental and societal issues. We take the measurement proposed by Afshar Jahanshahi et al. (2017) that modified the scale suggested by Muñoz & Dimov



(2015, p. 13). To measure Entrepreneurial Orientation (Parente et al 2020, p.7), we follow Tang et al. (2008), then we used two of the dimensions (risk taking and proactiveness) to predict the nature of the third dimension (technology /innovation adoption).



**Figure 3. From the literature to the Explorative Qualitative Analysis**

*Source: authors' elaboration.*

*Proactiveness* can be considered as a proxy of Network and Ecosystem development (Parente et al. 2018), to get knowledge and technologies from outside in order to compensate firm's lack. *Risk taking* reflects how entrepreneurs rely their own funds instead of public funds (Van der Meer & Noordam 2004) and private funds (Echeverría & Elliott 2002) to develop new technologies in agriculture. Rauch et al. (2009) argue that risk taking involves taking bold actions by venturing into the unknown, borrowing heavily, and/or committing significant resources to ventures in uncertain environments. To measure risk taking, we adopt the measures already consolidated in the literature (Eastwood et al. 2017; Freeman & Soete 1997). When entrepreneurs give high importance to the financial external support, they show a low level of risk taking. They are risk taking when they rely on their own funds. Then, stemming and stakeholders. *Empowerment* is the delegation of power and responsibility from higher levels of the organizational from these metrics and considering previous surveys used to analyze the posture of HumEnt (Kim et al. 2020; Parente et al. 2018), we created a survey able to highlight the factors that most influence the exploitation of opportunities through the adoption of new technologies.

Then, we asked entrepreneurs to feel free to indicate other useful items. We involved in the survey, a sample of entrepreneurs belonging to the agriculture associations that operate in a marginal Italian region (Calabria), with a strong vocation for agricultural activities.



**Regional Context**

Calabria is an Italian region, with 1.965.000 people, and is the 10th administrative NUTS2 region in Italy in terms of population. Calabria is situated in Southern Italy (also known as the Mezzogiorno). It is characterized by weak industrial development that has, generated a remarkable relevance of agriculture even today. In Calabria entrepreneurship is a relatively recent phenomenon, even if it is one of the Italian regions with the majority of privately owned agricultural land and farmers only in recent times have developed entrepreneurial attitudes. In the recent years, Calabrian agriculture has shown some signals of vitality (Svimez Report 2017), thanks also to the collaboration with a large and robust research system of excellence. Specifically, the recent growth is based on the specialization of some distinctive agricultural products, such as olive oil and citrus fruits (with the only cultivation of bergamot worldwide). This region is investing in different activities also along the agro-food supply chain, showing a prompt response to some emerging market trends such as those of biologic and nutraceuticals.

**Survey and Sample Description**

The research instruments included mailed questionnaires, developed from a review of the literature and through other researches in human resources, economics, and management.

The questionnaire was divided into two segments: the first one refers to demographic data as gender, age, education level, and characteristics of the firms, using multiple-choice questions and dichotomous ones. On the other hand, in the second one were asked to respond to a list formed by 20 items that refers to latent factors. Each item was given to the samples by questions in Likert-type scale, that allowed the complete analysis of those. The Likert-type scale ranged from 1 ("strongly disagree", "extremely unlikely", "negative") to 7 ("strongly agree", "extremely likely", "positive").

The reference sample consists of 130 subjects belonging to the Italian agricultural sector belonging to trade associations such as Confagricoltura, the Confederazione Italiana Agricoltori (CIA) and Caa-Copagri. Starting from April 2020, we send an email to all 1000 the associated farmers operating in Calabria, asking them to reply. We make a recall in November 2019 and at the beginning of January 2021, we get 130 answers.

The sample is characterized by a strong presence of men (109) compared to women (22) with a considerable variety in the year of birth of the farmer passing from 1933 to 2002, with an age average of 70 years old, remarkably similar to the national data (Istat 2010, 2012)

The owners are characterized by a medium-high level of education also linked to the presence of young entrepreneurs. Since, most of firms are family firms, in the sample we find that most of the entrepreneurs are also employees. The latter are characterized by a medium-low land measure and most of the entrepreneurs are also landowners. Just over half of the companies (60%) belonging to the sample, employee external labor resources, along with employees belonging to the own family (40%). Most of the companies interviewed prefer to allocate their final product to the regional market (51%) and another rather substantial slice on the national one (32%). The remaining part prefers combinations of national and international markets, sometimes involving also external intermediaries.

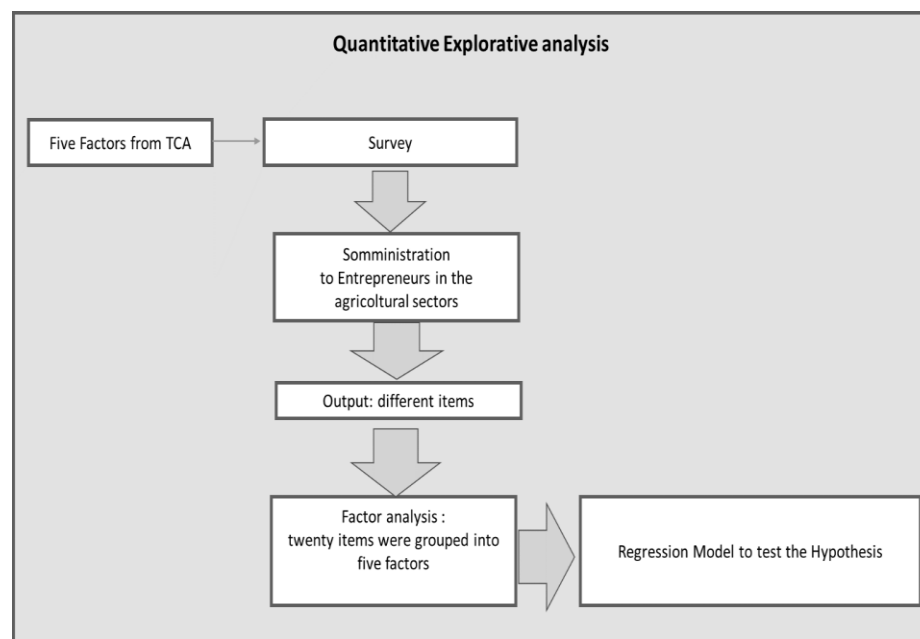
Referring to technology adoption attitude, from the survey it emerges that, half of the respondents have not adopted new technologies in the past 5 years, by confirming the trend of the national sector (Istat 2010, 2012).

However, they introduced organizational innovation. Most of entrepreneurs didn't adopt new technology because of the lack of in-house resources, in terms of knowledge, qualified workers and financial resources. Lastly, from the survey

y came out the low relationship between firms and universities or research centers.

### Factor Analysis

To select the principal components that led entrepreneurs to adopt new technologies (Rummel 1988). We run a *Factor analysis* that is an analytic technique (Narayanan et al. 2020) applied in several research in the entrepreneurial field (Kadile & Biraglia 2017). All the research design process is shown in the following picture (Figure 4).



**Figure 4. Quantitative Explorative Analysis: main steps**

*Source: authors' elaboration*

Then, to meet our research hypotheses, we considered twenty items (Table 1) that, coherently with Parente et al. (2018), we assigned into different categories of independent variables. The analyses were performed using SPSS. We screened the factor items through an explorative factor analysis based on Principal Components Analysis (PCA), aiming to identify which driving components can explain the most variability of the surveyed items. All variables have been measured on a *Likert scale* (0-7) and in the evaluation of the proposed items, there is an excellent reliability in which Cronbach's Alpha (1957) assumes the excellent value of 0.93. We summarized all the variables in Table 1 below, showing all the descriptive statistics.

Each component, whose eigenvalues result greater or very close to 1, ranks into the first 5 ones and describes the essential information of the survey. Indeed, the overall 5 factors express almost the 72% of the cumulative variation of all the 20 original item of the survey. The KMO (Kaiser-Meyer-Olkin) index is created by comparing the correlation coefficients with those of partial correlation, In the present case, a value of 0.83 is particularly acceptable. As regards the Bartlett sphericity test, it is used to test the hypothesis that the correlation matrix is an identity matrix, it is significant at every level. Concerning the factor rotation, the varimax method was chosen; it is a type of orthogonal rotation in which the axes with respect are kept orthogonal with respect to which the factors are positioned, remaining unreal

teed to each other. The criterion to establish when a factor saturation is to be considered significant is  $> |.40|$ . In our case we have excellent factor saturations, which refer uniquely to a single component.

**Table 1. Descriptive Statistics**

Items	Mean	Standard deviation	Analysis N
Create equal opportunities among workers	5,85	1,162	130
Willingness to collaborate with workers	5,36	1,375	130
Develop new skills and knowledge among entrepreneurs and workers	5,41	1,534	130
Communicate with collaborators	5,15	1,723	130
Allow workers to exploit inventions and ideas	4,38	1,606	130
Encourage workers to exploit their knowledge	4,65	1,760	130
Environment sustainability	5,64	1,258	130
Economic Sustainability in terms of value added	5,68	1,141	130
Economic Sustainability in terms of productivity	5,55	1,100	130
Economic Sustainability in terms of cost reduction	5,36	1,251	130
Social Sustainability for society and citizen	5,02	1,141	130
Social Sustainability for the supply chain	5,20	1,144	130
Proactiveness to catch info from outside	6,08	1,207	130
Proactiveness to catch info from innovation broker	6,35	,861	130
Proactiveness to catch info from socialization process from outside stakeholders	6,38	,883	130
Proactiveness to catch opportunities from universities and research centers	5,55	1,398	130
Innovativeness that considers the desire for learning and improving	5,20	1,460	130
Proactiveness to catch opportunities from the support of technology transfer offices	5,52	1,410	130
Risk taking and the importance of public funds	5,65	1,478	130
Risk taking and the importance of private funds	5,26	1,563	130

*Source: authors' elaboration*

All the twenty items are grouped in the five groups, embracing the main clusters areas identified in the theoretical session by applying the **Human Entrepreneurial Orientation** to the agricultural sector.

The first group of empirical factors is related to **Human Resource Orientation (EEEE)** that explains the feeling of farmers to involve their employee in firm's decision, that wants to guarantee equity among workers and has the willingness to promote the development of human resources (Cronbach's alpha = 0.834).

The second group refers to **Sustainable Orientation (ENCISO)** (Cronbach's alpha = 0.886), and it takes two main items. **Environmental Sustainability Orientation (ENSO)** allows to measure the positive effects of adoption of technology in terms of reduction of wastes of production factors, quality of production; These items can be linked to the ecological benefit. The other is **Economic Sustainability Orientation** that considers the needs of farmers to increase the value of firm both in the long run and in the short run. It is related to the increase of productivity.

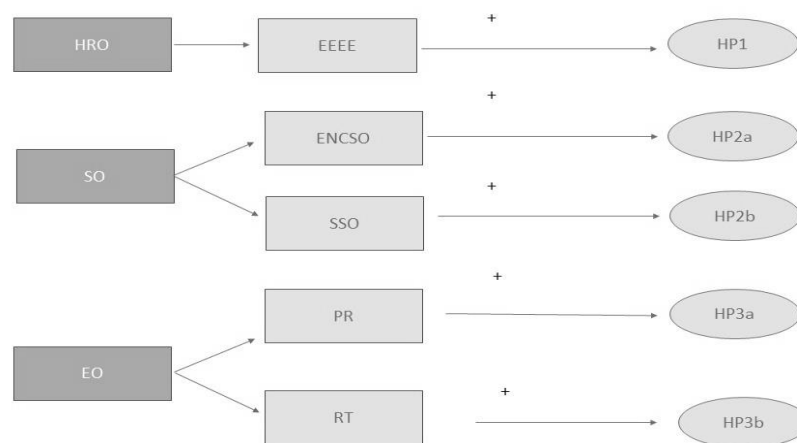
The third cluster is related to EO and specifically to **Proactiveness (PR)**, that is related to the need of Network and Ecosystem Development (Parente et al. 2018), in order to catch new opportunities from outside. In most of the firms, in fact, internal knowledge are not adequate to develop new technologies, so there is the necessity to force their integration with "external" knowledge from scientists, experts or simply colleagues in the sector (Cronbach's alpha = 0.816). Differently from the suggestions of theoretical analysis, from the quantitative analysis comes out that the dimension of **Sustainable Orientation** in the **social perspective (SSO)**, results to be an *autonomous* cluster. **Entrepreneurs**, in fact, give a great importance to this dimension because it refers to farmers' values to generate benefit for the society. The desire to improve local capacity-building, to generate change in traditional farming and to enhance rural residents' wellbeing and to reduce the unemployability, in fact, can contribute to increase the intention of farmers to adopt new technologies. Social responsibility of entrepreneurs appears to be very strong, along with their love for lands and for their roots (Cronbach's alpha = 0.753). The fifth group consider the EO dimension and specifically **risk-taking (RT)** items. If entrepreneurs rely on external financial support to promote the activities of firms, he has a low level of risk taking and vice versa (Cronbach's alpha = 0.768). The results of the factor analysis are reported in Table 2 and 3.

**Table 2. Variables description and measurement**

Factor Variables	Label	Description	Measures	Hypothesis
HEO	EEEE	A measure of Human Entrepreneurial Orientation across the items of: equity, empathy, empowerment and enablement.	0-7	Hp1
SO	ENC SO	It is a proxy of Environment and Economic Sustainability Orientation	0-7	Hp2a
SO	SSO	It is a proxy of Social Sustainability Orientation; from the factor analysis it come out as an autonomous factor	0-7	Hp2b
EO	PR	It is a proxy of proactiveness.	0-7	Hp3a
EO	RT	It is a proxy of Risk Taking within the dimension of EO	0-7	Hp3b

Source: authors' elaboration

Taking the results from the Factor analysis, we reformulate the Hypothesis as follows (Figure 5):



**Figure 5. Hypothesis to be tested.**

Table 3. Factor analysis: main results

Cluster	Label of Factors	Items		Components				
				1 EEEE	2 ENCISO	3 PR	4 SSO	5 RT
HRO	EEEE	Equity	Create equal opportunities among workers	0,649				
		Empathy related to the willingness of collaborators	Willingness to collaborate with workers	0,653				
		Enablement that consider the opportunity to develop skills and knowledge	Develop new skills and knowledge among entrepreneurs and workers	0,766				
		Empathy to communicate with collaborators	Communicate with collaborators	0,676				
		Empowerment of workers to exploit technologies	Allow workers to exploit inventions and ideas	0,785				
		Empowerment of workers to exploit their knowledge	Encourage workers to exploit their knowledge	0,794				
SO	ENCISO	Environment sustainability	Environment sustainability		0,807			
		Economic Sustainability in terms of value added	Economic Sustainability in terms of value added		0,748			
		Economic Sustainability in terms of productivity	Economic Sustainability in terms of productivity		0,784			
		Economic Sustainability in terms of cost reduction	Economic Sustainability in terms of cost reduction		0,755			
EO	PR	Proactiveness to catch info from outside	Proactiveness to catch info from outside			0,723		
		Proactiveness to catch info from innovation broker	Proactiveness to catch info from innovation broker			0,890		
		Proactiveness to catch info from socialization process from outside stakeholders	Proactiveness to catch info from socialization process from outside stakeholders			0,837		
		Proactiveness to catch opportunities from universities and research centers	Proactiveness to catch opportunities from universities and research centers			0,472		
		Proactiveness with the external actors	Proactiveness as the necessity to learn from outside			0,581		
		Proactiveness to catch opportunities from the support of technology transfer offices	Proactiveness to catch opportunities from the support of technology transfer offices			0,624		
SSO	Social Sustainability for society and citizen	Social Sustainability for society and citizen				0,833		
	Social Sustainability for the supply chain	Social Sustainability for the supply chain				0,783		
RT	Risk taking and the importance of public funds	Risk taking and the importance of public funds					0,862	
	Risk taking and the importance of private funds	Risk taking and the importance of private funds					0,695	
				<i>Principal component method</i>				
				<i>Varimax in 9 iterations</i>				

### The regression model

We consider the intention of entrepreneurs to adopt new technologies as *dependent variable* (*TECH\_AD*). We summarized all the variables and the correlation matrix in Table 4 below.

**Table 4. All variables and correlations**

		Correlations					
		Tech.Adoption	EEEE	ENC SO	PR	SSO	RT
Pearson Correlation	Tech.Adoption	1,000	,694	,295	,222	,170	-,072
	EEEE	,694	1,000	,000	,000	,000	,000
	ENC SO	,295	,000	1,000	,000	,000	,000
	PR	,222	,000	,000	1,000	,000	,000
	SSO	,170	,000	,000	,000	1,000	,000
	RT	-,072	,000	,000	,000	,000	1,000
N	Tech.Adoption	130	130	130	130	130	130
	EEEE	130	130	130	130	130	130
	ENC SO	130	130	130	130	130	130
	PR	130	130	130	130	130	130
	SSO	130	130	130	130	130	130
	RT	130	130	130	130	130	130

Source: authors' elaboration

Specifically, we developed a regression models based on the items of table 4. We take as dependent variable **the intention** to adopt new technologies.

$$TECH\_AD = \beta_0 + \beta_1 EEEE + \beta_2 ENC SO + \beta_3 PR + \beta_4 SSO - \beta_5 RT + \varepsilon$$

R square, goodness of fit of a linear model, assumes a value of 0.65, that had been considered positively. Furthermore, the Durbin-Watson test, is around 2, verifying the absence of autocorrelation of the residues. Test F turns out to be significant at every level. From the regression analysis come out that all the coefficients are significantly different from zero.

The p-value test, which verifies the hypothesis that the coefficients are zero, is rejected at all levels of significance.

It should be noted (Table 5), that, all the Hypothesis are verified except for Hp3b that is related to risk taking. Even the coefficient is negative, it seems that the financial aspects are not significant for farmers who want to adopt new technologies. All the other factors are significant.

**It was verified the absence of multicollinearity with** tolerance's index and V.I.F.'s index, in fact with  $T = 1$  the collinearity doesn't exist. In addition it was verified the homoscedasticity, since the average of the standardized residual turned out to be zero, and all were confirmed.

Table 5. Regression Analysis

Coefficients <sup>a</sup>										
Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95,0% Confidence Interval for B		Collinearity Statistics		
	B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF	
1	(Constant)	5,431	,077		70,674	,000	5,279	5,583		
	EEEE	1,012	,077	,694	13,113	,000	,859	1,164	1	1
	ENCSO	,430	,077	,295	5,573	,000	,277	,583	1	1
	PR	,324	,077	,222	4,199	,000	,171	,477	1	1
	SSO	,248	,077	,170	3,211	,002	,095	,400	1	1
	RT	-,105	,077	-,072	-1,360	,176	-,258	,048	1	1

a. Dependent Variable: Tech.Adoption

Source: authors' elaboration

## Discussion

The purpose of this paper is to apply the Humane Entrepreneurship Strategic posture (Bae et al. 2018; Kim et al. 2018; Parente et al. 2018; Parente et al. 2020) to the agricultural sector. It is a new model of entrepreneurship in which the attention of firms is concentrated on firm members, on the planet, and on the society. We apply this new posture to the agricultural sector, because we think that is one of the most appropriate, since the major transformations in the agricultural systems have the main aim to ensure a secure and healthy future for all people and the entire planet (FAO 2017).

The paper attempted to verify the effect of the different dimensions of HEO on the propensity of farmers to adopt new technologies. All the results show that all the dimensions of HEO are relevant in the propensity to adopt new technologies, except for risk taking. In fact, it seems that the entrepreneurial intention to adopt a technology in agriculture, is not influenced by the chance to benefit of public or private funds. This is coherent with the "entrepreneurial soul" of farmers. They are developing core entrepreneurial skills and agricultural sector is becoming more market driven and less dependent on government subsidies (McElwee 2008).

All the results highlight several implications for businesses, for the research system and for public policies. Within the boundaries of firms, entrepreneurs should share with employees, the organizational mission and vision, and encourage them to dream. They should inspire the spirit of openness and collaboration by empowering employees to increase their passion and their autonomy in doing their jobs. They should keep the mindset of opening, sharing, and cooperating with employees. Entrepreneurs should promote social responsibility and ethics within the firm; they also should maintain a spirit of fairness and equality through unobstructed human relations, while engage in external stimulus. Moreover



r, Entrepreneurs should quickly recognize crisis coming from environment changes and should be able to overcome t

he crisis, changing threats into opportunities. Specifically, firms belonging to the agricultural sector could start to collaborate with innovation managers able to create a matching with the research system and also with other farmers, to collaborate effectively and to develop process and product innovation through the acquisition of new knowledge from outside. Entrepreneurs in agriculture should be rethinking. They need a new culture, new education and new leadership style.

Universities and research centers from their side, can gain the opportunity to exploit their knowledge, by applying at the industrial level, their knowledge, their inventions, with the challenge to create new products and new processes. The creation and development of networks with universities and research centers are required by the agricultural community, especially given their high-tech knowledge. In the relation with other actors, farmers need the right support to explain their technological needs. They require the support in the scouting and in the assessment of new technologies that could be useful to adopt. In recent years, understanding the importance and usefulness of the approach to innovation systems (Klerkx & Leeuwis 2008) and concepts of innovation and scientific networks, a group of actors in the system called intermediaries, brokers or facilitators have gained specific attention by guaranteeing brokerage services that could guarantee universities and research centers (Bayona et al. 2017). Moreover, Universities can catch the opportunity to offer to farmers some training courses on the technology transfer field, in order to increase the level of knowledge and their awareness of the importance of technology adoption, especially for companies that experience generational change.

Most of the effort from public policies is to provide funds for innovation in agriculture, in order to encourage the adoption of new technology. Our analysis has shown that this policy should be associated with other public services that helps farmers, across the scouting process and in the assessment of new technologies. Only if farmers become aware of the real value of new technologies can use the private and public funds to introduce them into the farm (Lee 2020). The farmers take advantage of new technologies if they have personal attitudes, skills and knowledge to innovate combined with adequate skills and organizational innovation culture, in fact, a large part of farmers is normally reluctant to introduce technologies, not so much for the monetary investments they entail, but for the reluctance to learn innovations. In marginal regions, there is not an entrepreneurial ecosystem that must be created. Thus, entrepreneurs in the agricultural sector, especially in rural and marginal regions, require more attention and support, in order to get new challenges (Byerlee et al. 2002). There is the necessity to create an entrepreneurial culture and to develop a network system among different actors. This implies first of all a process of knowledge dissemination, then a process of competences' creation. The creation of an entrepreneurial culture must be carried out since the university education period. Universities and entrepreneurial associations should propose entrepreneurship courses and professional training courses, especially for young entrepreneurs. Workshop and events are also crucial to disseminate the entrepreneurial culture and all the information regarding innovation opportunities, new technologies, new inventions for the agricultural sector.

### **Conclusions, Limitations, and Further Research**

The contribution of this study is twofold. First, it offers a contribution to the literature on entrepreneurship (Tarabishy

and et al. 2020) and specifically gives new insight to the topic of Human Entrepreneurship. Since the development of t

his new “posture” is very recent, in fact, it needs experimental applications. Then, we propose an empirical application by analyzing the combination of some heterogeneous factors in a very promising sector. Second, even if agriculture is a very peculiar sector and it is quite different from manufacture (Vermeire 2009), also farmers can be considered as entrepreneurs. Thus, we transfer in this sector a new theory that is still used in non-agricultural sectors (Mcelwee 2006). So, we enrich the literature on agriculture EO that is relative shortage of empirical studies in the specific sub-field (Dun g et al. 2020).

It has some limitations. It considers only a specific marginal Italian region that is Calabria. Further research will be replicated on the entire country and will be extended also with a cross countries analysis. Although it still requires further study to better develop and empirically validate the constructs, the use of this type of work, both at regional and national level, can certainly contribute to the definition of important solutions and measures in support of policies of development in the agricultural field. Following Irwanti, et al. (2020) future research will test the mediator effect of technology adoption in the relation between firm performance and the independent variables.

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#### **APPENDIX A**

- Which are the main factors that encourage you to adopt new technologies?
- Which is the importance of workers in the process of technology adoption?
- Which are the most important factors that can encourage entrepreneurs in the process of technology adoption?
- Do you have technological competences inside your firm boundaries?
- How is important for you to create relations with other actors?
- Which is the importance of external funds in the adoption of new technologies?
- Do you think that “human capital and human relations” are important in the process of technology adoption?
- Could you please list the main factors that enhance your intention to adopt new technologies to improve your processes and /or your products?

## 요약문

농업 기업가의 과학 기술적 경향은 새로운 기회를 식별하고 탐구하기 위해 필요해지고 있다. 최근 연구에 따르면 신기술의 채택은 기업가적 지향(EO)의 광범위한 접근법과 일치한다. 농업의 타당성이 증가하고 있다고 해도, 기업가적 연구는 대체로 이 도전적인 분야를 간과해 왔다. 게다가, 문헌에는 경험적 연구가 상대적으로 부족하고 여전히 연구되어야 하는 부분이며 잠재력이 있다고 논하고 있다. EO의 문헌에서 비롯된 이 연구는 농업 분야인 HEO(Humanine Entrepreneurial Orientation)의 접근을 제안한다. 이 논문은 HEO의 다양한 치수가 농가의 신기술 채택 성향에 미치는 영향을 검증하기 위한 경험적 분석을 제안한다. 모든 결과는 기업, 연구 시스템 및 공공 정책에 대한 몇 가지 시사점을 강조한다. 농업이 매우 특이한 분야이고 제조업과 상당히 다르더라도 농민도 기업인으로 볼 수 있으며 기업가정신을 따를 수 있다고 본다. 따라서, 경험적 연구의 상대적으로 부족한 농업 EO에 대한 문헌을 본 연구를 통해 풍부하게 할 수 있다고 본다.