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Stakeholders' Perception of Xylella Fastidiosa (Xf) Disease Risk Assessment: First Results from Puglia (IT), Chania (GR), Valencia and Andalucia (ES)

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Abstract

Xylella fastidiosa (Xf) is an aerobic, Gram-negative bacterium of the monotypic genus Xylella. It is transmitted exclusively by xylem fluid feeding sap insects. Xf is one of the most dangerous plant bacteria worldwide, causing a variety of diseases, with huge impact for agriculture, and affecting cultivated plants of high economic value (e.g., olive trees, stone fruits—plums, almonds, cherries) or wide-spread ornamental plants (e.g., myrtle-leaf milkwort, oleander). In the frame of H2020 Project XF-ACTORS, analysis of the environmental, socio-economic and governance impact and vulnerability to Xf have been carried out in selected case study areas. To reach this goal, an extensive survey was conducted with the support of a comprehensive questionnaire in Puglia (Italy), Crete (Greece), Valencia and Andalusia (Spain). Questionnaires were completed through face-to-face interviews with local farmers, decision makers, extension experts and practitioners. The survey aimed to: 1) collect the point of view and perception of people about Xf disease and the containment plans; 2) identify possible gaps in communication, understand possible weak points in the communication strategy that could hamper the application and the effectiveness of containment measures; 3) understand the network of relationships existing among stakeholders in territorial contexts; and 4) collect suggestions from local people with a view to improving the management of information related to the disease. Questions were grouped under different main criteria: Knowledge, Perception, Practices, Involvement, Effectiveness, Responsibility. A scoring procedure assigned to each question a value to assess the corresponding indexes: DKI-Disease Knowledge Index, DPI-Disease Perception Index, FPI-Farm Practices Index, INV-Involvement Index, EFF-Effectiveness Index, RES-Responsibility Index. The overall values of RISK (DKI/DPI/FPI) and GOVERNANCE (INV/EFF/RES) were then obtained. To investigate linkages (correlation and causation) between Governance and Risk (perception and management) domains as well as among their indices, Structural Equation Modelling (SEM) technique was adopted. The proposed methodology proves to be useful to describe attitudes of respondents when facing the epidemic, as well as how they appreciate and tackle disease management. The work allows practical suggestions to be made to improve the knowledge-perception relationship that directly influences willingness to adopt preventive/control measures against the pathogen, and consequently will increase the efficiency of Xf disease management. The result of the whole analyses confirmed that the engagement of stakeholders, the involvement of expert groups (enlarged to experts in economy and social science) and an appropriate communication strategy are essential for a successful implementation of phytosanitary measures.

Keywords

Risk Perception, Governance, Xylella Fastidiosa, Plant Disease, Stakeholders' Attitude

1. Introduction

Xylella fastidiosa (Xf) is an aerobic, Gram-negative bacterium of the monotypic genus Xylella. It is transmitted exclusively by xylem fluid feeding sap insects. Xf is one of the most dangerous plant bacteria worldwide, causing a variety of diseases, with huge impact for agriculture, and affecting cultivated plants of high economic value (e.g., olive trees, stone fruits—plums, almonds, cherries) or wide-spread ornamental plants (e.g., myrtle-leaf milkwort, oleander).

XF-ACTORS—Xylella Fastidiosa Active Containment Through a multidisciplinary-Oriented Research Strategy project[1] (Grant Agreement n. 727987) aims to establish a multidisciplinary research programme to answer the urgent need to improve prevention, early detection and control of Xylella fastidiosa (Xf) under different phytosanitary conditions, and maximize the impacts of EU research programs by ensuring coordination and integration amongst research groups and networks with long lasting experience and/or involved in ongoing international research programs on Xf.

This paper would like to present the first results of a comprehensive stakeholders' survey, conducted in different municipalities belonging to three case study areas (Italy, Greece, and Spain), aimed to evaluate the risk perception of respondents to the possibility of being affected by the disease and its impact, as well as the degree to which the respondents have a favorable or non-favorable

[1]XF-ACTORS project: https://www.xfactorsproject.eu/

evaluation of the adoption of control/mitigation measures (Breukers et al., 2012). This assessment assumes that changes in farmers' practices and overall strategies are the result of changes in farmers' knowledge, attitudes, and perceptions.

2. Background

Knowledge, perception, risk, and governance

Risk is a highly complex concept, commonly seen as a multi-dimensional construct and related to uncertain and negative consequences (Renn, 1998; Slovic et al., 1982). Risk is very much context-related; it is also dynamic and changes over time in response to many external factors, new information and communication among people. The perception of risk is an important part of life and perceiving a risk as too low or too high may have a negative impact on the person's well-being. Risk is defined as "the probability (or frequency) of occurrence of a threat or hazard and the possible impacts of this occurrence, risk is a multi-faceted and subjective concept" (Adams, 1995; Slovic et al., 2002; Gaillard & Dibben, 2008; Renn, 2008). Risk is linked to **uncertainty**, which Fish et al. (2011) describe as "an inherent and inescapable attribute of decision-making processes that aim to prevent, anticipate and alleviate (animal) disease". Risk is also an inherent feature of farming practices and the management of different value chains of agricultural sector.

Summarising the ways in which humans understand risk, Slovic, Finucane, Peters, and MacGregor (2004) identified two main forms of risk:

1) *Risk as analysis*, an analytical system based on algorithms and normative rules that uses logic, reason, and scientific deliberation to inform risk management decisions. This analytical system is slow, effortful and one that requires conscious control.

2) *Risk as feeling*, an experiential system that uses fast, instinctive, and intuitive reactions to danger. Thus, risk is something that is inherently subjective and assumption-based, rather than something that can easily be defined or objectively measured and quantified.

As Sligo and Massey (2007) note, the former tends to be decontextualized and objective, while the latter is based on trust, mutual reciprocity, experience, and observation. These different types of risk and uncertainty are not mutually exclusive and, in current practice, interact. While risk assessment relates to scientific and "experts" solutions, risk management deals more with policy making and hence with uncertainty.

Research suggests that people's reactions vary according to different types of risk and uncertainty; once a judgement is made about a particular risk, it can be difficult to change that view, especially if the individuals feel they are well-informed about the subject (Adams, 1995). Similarly, personal experiences, memories (e.g., past disease events) and societal values can play an important part in the perception of risk and thus influence decision making.

Therefore, risk perception plays a key role in risk management, as growers and other related sector actors do not behave in a purely technical and rational manner (Breukers et al., 2012). In other words, they will rarely react to technical risk assessments alone and will also be guided by a sort of "cultural rationality" (Fischer, 2005) that is widely influenced by practical considerations such as personal and familiar knowledge and experience. However, this experience is often individual, and it is therefore a challenge to implement the organisational procedures required to collect the experiences and to ensure that they are shared amongst all actors (Wybo et al., 2002). Risk perception is influenced by different factors, including the type of risk, the risk target (who is affected), cognitive processes as well as values and emotions (for example, fear) of the person/s judging the risk (Sjöberg, 2000). The research methodology used in studies could influence the assessment of risk perception.

Risk perception is anyway influenced by knowledge. The present literature distinguishes between **objective knowledge** (what a person knows about a topic and related risk/s) and **subjective knowledge** (what a person presumes to know). The relationship between objective and subjective knowledge may depend on several factors, such as the extent to which media gives information about the risk object. Sometimes people appear to overestimate their knowledge within many kinds of domains, but in general their objective and subjective knowledge tends to be positively related. Subjective knowledge seems to be the most common and influencing factor in assessing risk perception. Some studies (Jaccard et al., 2005; Grasmuck & Scholz, 2005) shows that a higher subjective knowledge is often associated with a lower risk perception. Thus, in this situation, inadequate behavior and/or low awareness of adopting initiatives to avoid/prevent risk or to mitigate impacts are generally dominant.

Governance is a concept that has long assumed a position of theoretical importance in several fields of social science (Renn, 2008); it is developed here to inform an alternative approach to plant disease control and management. Governance is often contrasted with the more established notion of government. While the latter refers to the formal institutional apparatus and decision-making processes of the state, the former is broader in scope and relates to the distribution of decision-making power within and outside the state (Stocker, 1997).

Public policy is often focused at the national (state) level, but many food and natural resource policies as, for example, biodiversity (Simoncini, 2010) operate at levels below the national level and, increasingly, beyond it. In the food value chain, as in many other economic sectors, governance is largely preoccupied with the management of risk, both perceived and statistically formulated (Slovic et al., 2004) and there is an extensive literature on risk and risk perception. As Renn (2008) puts it: "*Risk governance looks at the complex web of actors, rules, conventions, processes and mechanisms concerned with how relevant risk in-*

formation is collected, analysed and communicated, and how management decisions are taken."

By combining the risk-relevant decisions and actions from both governmental and private actors, the notion of risk governance is particularly applicable to certain situations. This is especially true for the present plant health and plant disease management system, where there is not one only authority charged for risk-management decisions; instead, the nature of the risk depends upon more or less coordinated decisions taken across a range of different stakeholders and contexts.

There is recognition that a science-centered basis for decision-making is a necessary, but not sufficient condition for improved plant health governance and management of plant disease.

3. Methodological Outline

Several factors affect the level and the success of a containment strategy for Xylella fastidiosa disease:

- Stakeholders' level of knowledge of disease.
- Stakeholders' perception of risk disease and related social and economic impacts.
- Effective governance of the information and decision-making process.

To assess how these factors are relevant in influencing stakeholders' strategies in facing the disease, an extensive survey was conducted by XF-ACTORS project in different case study areas.

The **survey's main objectives** were:

- Collect the point of view and perception of people about the Xf diseases and the related containment plans, in order to suggest modality of interventions able to prevent local people disappointment and reactions and build consensus about the application of containment measures in the future;
- Identify possible gaps in communication, understand possible weak points in the communication strategy that could have hampered the application and the effectiveness of containment measures;
- Understand the network of relationships existing among stakeholders in the territorial contexts; and finally;
- Collect suggestions from local people that can help improving the management of information related to the disease.

There are several examples of questionnaires and/or public surveys aimed to collect information on risk perception; among the others: on anthracnose (Penet et al., 2016), on extreme weather events (Sulewski & Kłoczko-Gajewska, 2014), on climate change (Schattman et al., 2016), on potato and wheat diseases (Ilbery et al., 2012; Ilbery et al., 2013), on the tomato, tulip bulb, and strawberry disease (Breukers et al., 2012), on vegetables and legumes disease (Schreinemachers et al., 2015), on tomato disease (Déus et al., 2011) and, finally, in human disease outbreaks (ECOM, 2015). Based on this huge literature, a questionnaire was developed (in English, as well as in Greek, Italian, and Spanish).

Following a testing phase (carried on from June to July 2017 in 3 Municipalities into the infected area in south Puglia) and a further refinement (guidelines were also developed for selecting the pilot and target areas), the questionnaire was released, and the collection of interviews was carried on in Crete (GR), in Puglia (IT), in Andalucia and Valencia (ES) (**Table 1**).

Questionnaires were submitted through face-to-face interviews; than answers were collected by means of a computer-assisted software (©SurveyMonkey).

The methodology applied for Stakeholder's identification resembles the "snowball sampling methodology[2]" (Goodman, 1961), but allows also to build the map of the connections existing among the actors by drawing the relationship existing among them and measuring the intensity of such connections, according the REXAO method (Wybo & Van Wassenhove, 2009). This is useful (together with other specific questions of the questionnaire) to design the network of correlations existing among local people. After having performed the

Table 1. Sample size (number of interviews) conducted for each pilot area (corresponding to 64 Municipalities) in Crete (GR), in Puglia (IT), in Andalucia and Valencia (ES).

COUNTRY	REGION	PROVINCE	SITUATION	INTERVIEWS
GREECE	CRETE	CHANIA	NOT INFECTED	30
ITALY	PUGLIA	FOGGIA	NOT INFECTED	30
ITALY	PUGLIA	BAT	NOT INFECTED	10
ITALY	PUGLIA	BARI	NOT INFECTED	20
ITALY	PUGLIA	BRINDISI	NOT INFECTED	30
ITALY	PUGLIA	TARANTO	NOT INFECTED	30
ITALY	PUGLIA	LECCE	INFECTED	30
SPAIN	ANDALUCIA	CORDOBA	NOT INFECTED	53
SPAIN	VALENCIA	ALICANTE	INFECTED	30
			TOTAL	**263**

[2]Snowball sampling is a method commonly used where initial contact persons are asked for recommendations of people linked to them in their work. Snowball sampling methods, where one individual contacted in the research process might assist the researcher with locating others relevant for the research, are heavily influenced by the social networks of the people contacted initially. A strength of this approach is being integrated into 'trust networks'. A limitation can be that certain people who may be important to a system may not be referenced as actors, e.g., because of prejudices that exist within a particular community or group. Snowball sampling thus requires awareness of its limitations and can be complemented with other approaches as required for the research.

interviews, all correlations among people and roles were clearer as well as the kind of information which is involved in the exchange among them and their role and stake in the area.

The **questionnaire's structure** is made up of 13 different sections (General information, Productive context, Knowledge, Perceptions, Impacts from disease, Involvement in pest management relationships, Pest management practices, Information, Farm management and production strategies, Governance of risk management system for plant disease) and 63 questions (e.g., multiple-choice questions, yes/no questions, open-ended questions, Likert-type scale, matrix-table questions) aimed to collect data, but also opinions and un-official information, which are necessary to have a precise idea of the perceptions of local people in pilot areas. Questions belonging to specific sections of the questionnaire were grouped together referring to these specific criteria and their related indices.

The domains are the following:

RISK: The study is based on the concepts of disease knowledge, disease perception and willingness to apply practices already widely applied in literature and studies related to pest management decision making and risk assessment. Such assessment aims to provide us insights on what people know about the problem, how they feel about it, what they perceive to be the severity and causes of the problem, and what actions they currently take (Breukers et al., 2012). It assumes that changes in farmers' practices are the cumulative result of changes in farmers' knowledge, attitudes, and perceptions. The assessment of the risk perception is obtained as a function of the following three indexes:

1) **Disease Knowledge Index (DKI)**: this measures the level of knowledge of the respondents about the various aspects of Xf disease such as the knowledge of pathogen, its spreading (vector), symptoms, and preferred hosts plants.

2) **Disease Perception Index (DPI)**: this expresses the respondent evaluation of susceptibility/probability of a Xf attack in the near future and the corresponding expected or real impacts on production.

3) **Farm Practices Index (FPI)**: this expresses the level of implementation (or the willingness to implement) of prevention/containment/mitigation actions, the motivating/hindering factors (who determine the willingness or obstruct the execution of measures), the evaluation of their effectiveness and of the possible strategies to cope with the disease.

GOVERNANCE: In our view, risk governance pertains to the various ways in which many actors, individuals, and institutions, public and private, deal with the disease risks. The aim is to assess how respondents feel to be involved in and how they perceive the effectiveness of disease management, how much they know about who oversees manage the epidemic. Even in this domain, three indexes were applied:

1) **Involvement (INV)**: this expresses the level of respondents' involvement in

different activities (vigilance, information, extension, response, post-crisis actions, …) as well as the willingness to be involved into capacity building activities (workshops, training course, …) to face the disease.

2) **Effectiveness (EFF)**: this expresses the respondents' evaluation of effectiveness of Stakeholders' involvement as well as their trust in Public Authorities in control/manage the disease.

3) **Responsibility (RES)**: this evaluates the knowledge/awareness of the different level of responsibility (and corresponding authorities) in the disease management. Moreover, it provides insights about the stakeholders' opinion on who are the main influencers in the farmer's decision-making process.

In Table 2, the questions pertaining to the different indexes are reported.

Most of the above-mentioned questions are open-ended questions (free text), but specific keywords were targeted to rate basic knowledge of the disease (pathogen, symptoms, vectors, …). Answers to each of those questions were compared with a set of rules (e.g., keywords) and related scores. Answers matching with the settled rules were scored +1; answers that no match the rules were scored -1; and lack of answer was rated 0. The scores were assigned to each single answer, summed up and standardized in a range from 0 (e.g., low disease knowledge/risk perception/low farm practice) to 1 (e.g., high disease knowledge/risk perception/high farm practice). The average score for each index and the overall value for each domain were calculated.

At the end of this process, we can obtain 3 indicators for each domain and an overall index value for each domain (RISK, GOVERNANCE). In this way it is possible to display:

1) the average values for indicators, in the two different domains, for each Municipality,

2) the couple of values for domain indices (RISK, GOVERNANCE).

The scores for each Domain (Risk, Governance) were plotted by means of a triangles radar graph (see Figure 1(a), Figure 1(b)).

The overall value of the Domain (Risk, Governance) index represents the area of the triangle radar graph, as follows:

Table 2. Synopsis showing selected Questions for different Domains, Criteria, and related Indices.

DOMAIN	CRITERIA	INDEX	QUESTIONS
RISK	KNOWLEDGE	Disease Knowledge Index (DKI)	Q17, Q18, Q19, Q20, Q21, Q22
	PERCEPTION	Disease Perception Index (DPI)	Q23, Q24, Q25, Q26, Q27, Q28, Q29
	PRACTICES	Farm Practices Index (FPI)	Q35, Q36, Q37, Q38, Q39, Q40, Q41, Q53, Q54
GOVERNANCE	INVOLVEMENT	SHs Involvement Index (INV)	Q30, Q32, Q56
	EFFECTIVENESS	Effectiveness Index (EFF)	Q33, Q34, Q59
	RESPONSIBILITY	Responsibility Index (RES)	Q55, Q57, Q60, Q62

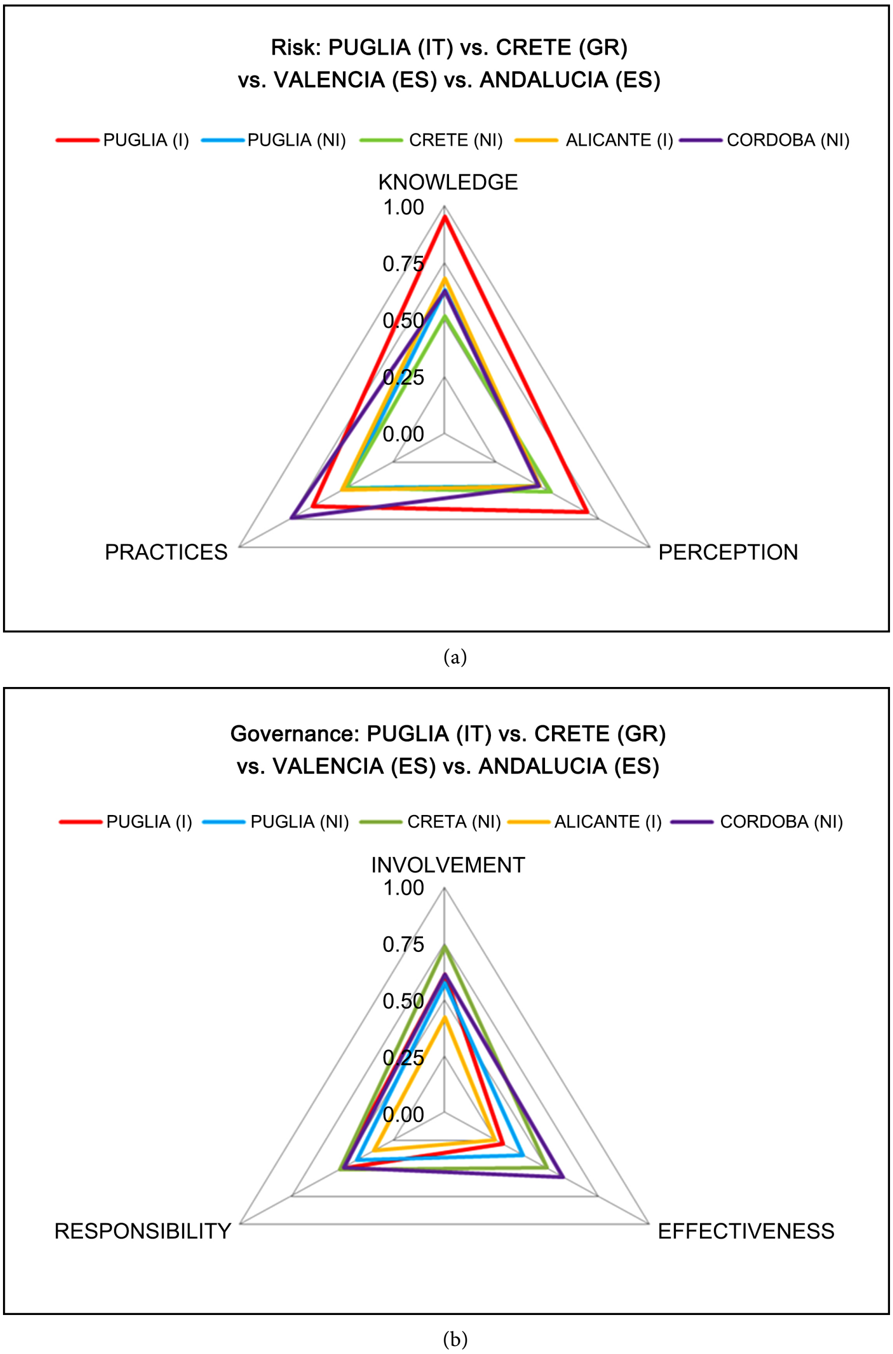


Figure 1. Examples of Country's Indicators for Risk (a) and Governance (b) domain plotted on triangle radar graph.

$$\text{RISK} = \frac{1}{2}\sin\frac{360^\circ}{3}\left(\text{DKI} * \text{DPI} + \text{DPI} * \text{FPI} + \text{FPI} * \text{DKI}\right) \tag{1}$$

$$\text{GOVERNANCE} = \frac{1}{2}\sin\frac{360^\circ}{3}\left(\text{INV} * \text{EFF} + \text{EFF} * \text{RES} + \text{RES} * \text{INV}\right) \tag{2}$$

To analyze results obtained from the survey conduction, a correlation analysis was carried out. Correlation was evaluated for the six indexes and for each domain as well as for country's context.

To investigate linkages between Governance and Risk (perception and management) domains as well as among their indices, Structural Equation Modeling (SEM) technique was adopted (Schumacker et al., 2004). SEM allows multivariate statistical analysis which make it possible to analyze linear relationships between variables from the analysis of the covariance among the variables.

Based on correlation carried out on the whole results coming from the same surveys in pilot areas, we could collect some general indications useful to propose general but important suggestions, to improve the efficiency of the governance systems in relation to the containment of Xf related disease.

4. Outcomes and Discussion

4.1. Sample's Description

Survey was conducted in 3 case study areas (Italy, Greece, and Spain) and 5 groups of pilot areas (corresponding to 64 municipalities): Puglia (Infected areas—IA), Puglia (Not Infected areas—NI)[3] (see **Figure 2**), in Crete (Not Infected areas—NI), in Valencia (Infected areas—IA) and Andalucia (Not Infected areas—NI). A total of 263 questionnaires were submitted (150 in Puglia, 30 in Crete, 30 in Valencia and 53 in Andalucia respectively) (**Table 1**; **Figures 3-6**).

The stakeholders interviewed in the case study areas present different characteristics as well as some similarities: in terms of the distribution into groups of age (about 71% of the respondents fall in a range between 41 and 65 years old), in terms of gender (men exceed 90% of respondents), in terms of education level (49% attended secondary school). The most part of respondents were farmers (73% as an average).

In all pilot areas (Municipalities) the more sensitive crop(s) (olive trees in Puglia and Crete; almonds in Alicante; olive, citrus, or grapes in Cordoba) have the highest incidence (on average 75%) on the total farm surface. For the average farm size, 38% of respondents' farms exceed 20 hectares. The average farm size has implications both in economic terms as well as in terms of effective application of containment measures.

Table 3 shows the differences between the case study areas.

4.2. Survey's Outcomes

4.2.1. Risk Domain

Disease Knowledge Index (DKI) decreases from infected zones of Puglia

[3]Following the introduction and the continuous spread of Xylella-infections in Apulia and based on the provisions enforced with the EU Decisions (Decision (UE) 2016/764 of the European Commission that modify the previous Decision of Execution (UE) 2015/789) the regional territory of Apulia has been demarcated in four main areas (Regional Law no.4 of 29 March 2017, furtherly modified by the Regional Law no. 64 of 22 December 2017. Briefly, the Demarcated Area (DA) are: 1) Infected Area (IA), 2) Containment Area (CA), 3) Buffer Area (BA) and 4) Xf-Free Area (FA). In our study, in Not Infected areas (NI) we include: CA-Containment Area, BA-Buffer Area and FA-Free Area.

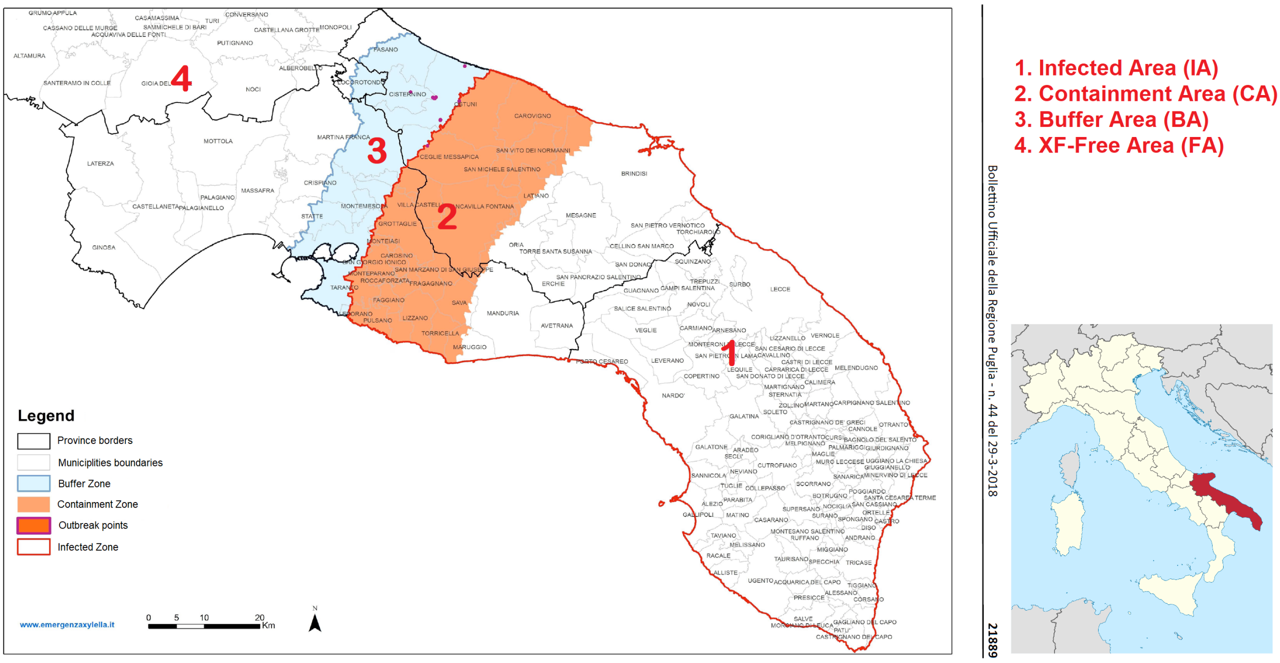


Figure 2. Different areas as defined by XF containment's Plan for Apulia Region (according with the Commission Implementing Decision (EU) 2016/764 of 12 May 2016 amending Implementing Decision (EU) 2015/789 as regards measures to prevent the introduction into and the spread within the Union of Xylella fastidiosa (Wells et al.) (notified under document C(2016) 2731)).

Table 3. Average characteristics of the surveyed stakeholders in the 3 case study areas (Puglia, Crete, and Spain).

	Country Region Situation total no. surveys	ITALY		GREECE	SPAIN	
		Puglia		Chania	Valencia	Andalucia
		Infected area (IA)	Not infected area (NI)	Not infected area (NI)	Infected area (IA)	Not infected area (NI)
		30	**120**	**30**	**30**	**53**
Age	<40 yrs	3	17	5	4	10
	41 < yrs < 65	22	86	23	20	35
	>65 yrs	5	17	2	6	0
Education	primary school	1	5	0	17	9
	preparatory school	2	30	0	0	2
	secondary school	17	67	19	12	13
	University Degree	10	18	9	1	29
	Msc - PhD	0	0	2	0	0
Prevailing activity (stake)	Advisors/extensioners	2	6	0	1	8
	Employee/worker	2	4	2	5	3
	Exporter	0	0	1	0	1
	Farmer	24	101	12	16	39
	Local government authorities	1	1	7	2	0
	Buyer/Processor	1	8	1	3	2
	Representative of collective organization	0	0	6	2	0
	Supplier	0	0	1	1	0
Average Farm dimension (if applicable)	≤5 ha	8	31	4	9	3
	5 < ha ≤ 20	8	43	15	11	15
	>20 ha	11	45	11	0	34
Farm surface covered by "sensitive" crops (%)		86.0	62.6	81.3	50.7	92.2

Figure 3. Case study: Puglia (Italy); state: Infected/Not infected (24 Municipalities, 150 questionnaires distributed) (Source: ©Google Earth).

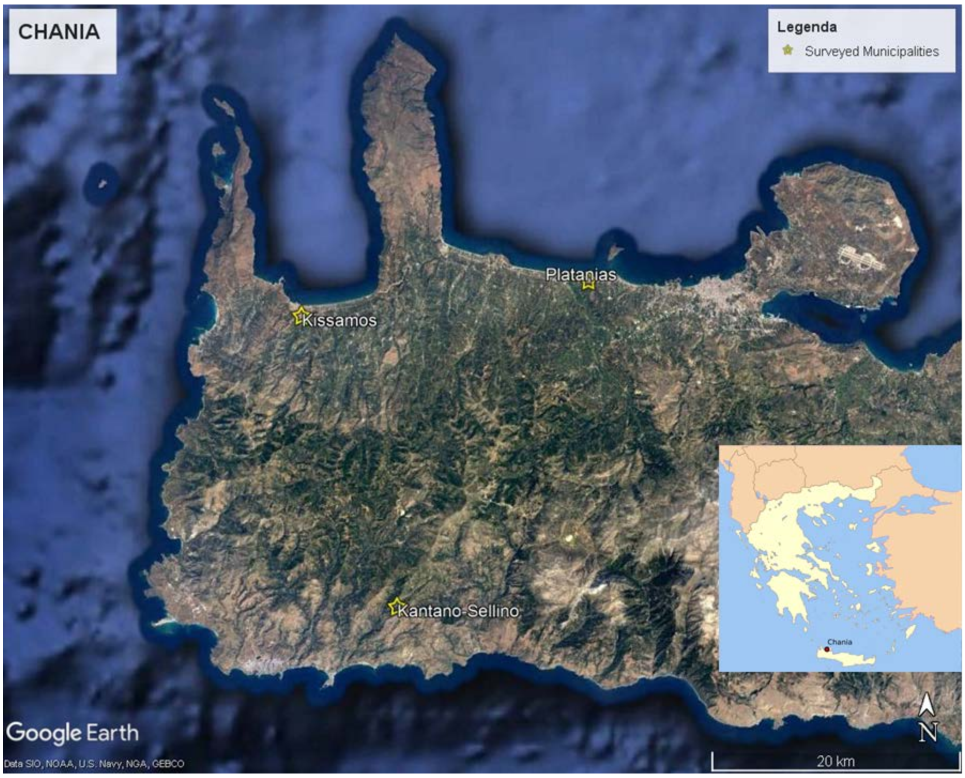


Figure 4. Case study: Chania (Greece); state: Not infected (3 Municipalities, 30 questionnaires distributed) (Source: ©Google Earth).

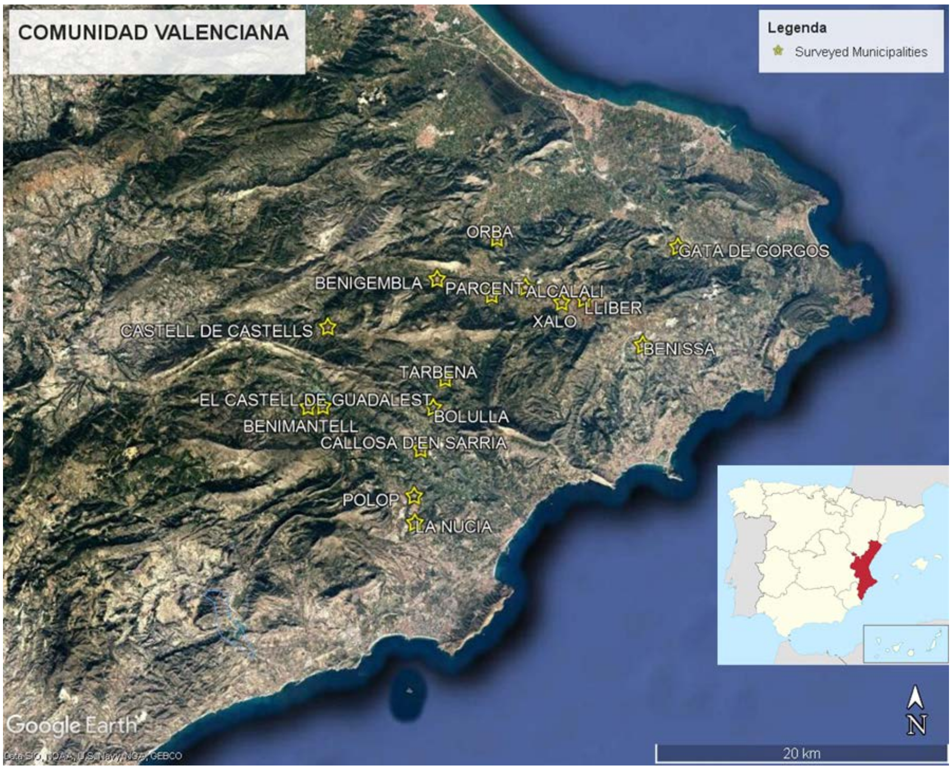


Figure 5. Case study: Valencia (Spain); state: Infected (17 Municipalities, 30 questionnaires distributed) (Source: ©Google Earth).

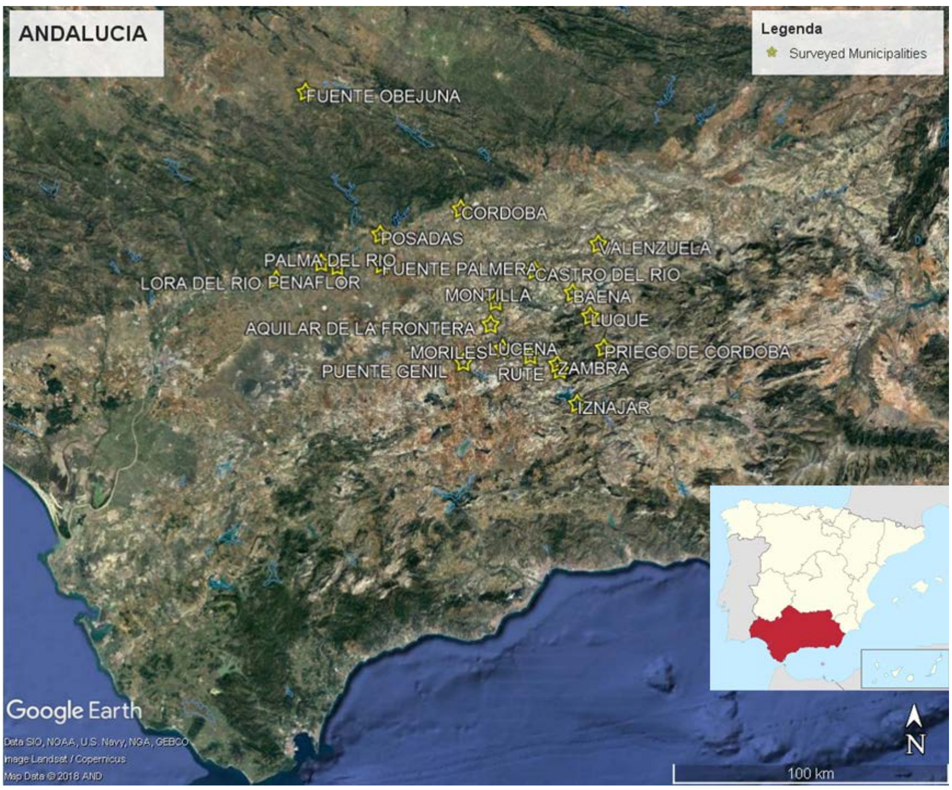


Figure 6. Case study: Andalucia (Spain); state: Not infected (20 Municipalities, 53 questionnaires distributed) (Source: ©Google Earth).

(IA-Infected Area) (0.95) to Not infected zones of Puglia (e.g., CA-Containment Area, BA-Buffer Area and NI-Not Infected or Free Area) (0.63). In Crete (considered as NI-Not Infected) DKI shows value lower than in Puglia (0.52). The level of DKI in Spanish pilot areas is very similar to that of municipalities in the not infected areas of Puglia: in Alicante (IA-Infected Area) is 0.68, in Cordoba (NI-Not Infected) is 0.63.

In Puglia DKI decreases moving from south to north, from the municipalities closer to the infected area to the municipalities located far from the infected area. The lower value of DKI is showed by municipalities in the Foggia province (0.51) in the northern part of Puglia region. All municipalities included in the Puglia's infected area (IA) show similar DKI, ranging between 0.92 to 0.97.

The survey shows that respondents have a good knowledge of Xylella. Interviewed people show to have a good knowledge of the pathogen, vector as well as OQDD (Olive Quick Decline Disease) symptoms. Respondents that know about Xf are respectively: 97% Puglia (I), 79% Puglia (NI) e 93% Crete (NI). The collected data for the Spanish Provinces of Alicante (infected) and Cordoba (not infected) show that a quite high portion of respondents know what OQDD is (84% in infected area of Alicante and 81% in not infected area of Cordoba respectively).

Regarding the **Disease Perception Index (DPI)**, differences between farmers' perception reflect the differences in the level of risk exposure. In fact, DPI decreases from infected areas (Puglia) to not infected (Puglia and Crete) where the perception is in general low. Disease Perception Index (DPI) in infected municipalities in Puglia is rather lower (0.69) than the maximum (1.00). Probably this is because the infection is already present in these areas. Perception about the probability of contamination in the next year in not infected pilot areas of Puglia is slightly higher than in similar areas in Crete or in Cordoba.

The perceived risk of Xf in not infected areas in Crete is slightly higher (0.51) than in similar areas in Puglia (0.46). DPI in Spanish pilot areas (Alicante 0.46, Cordoba 0.46) seems to be equal to the average of the not infected municipalities of Puglia.

As said before, **Farm Practices Index (FPI)** expresses the level of practices' implementation (or the availability to apply them). This is quite high (0.64) in the infected areas (I) of Puglia, where they are compulsory; these are followed by not infected areas (NI) of Puglia and the not infected (NI) areas of Crete (0.48).

In Spain (where control measures are applied to comply the Commission Implementing Decision (EU) 2015/789), FPI in Alicante (infected) shows value like Apulian not infected areas (0.50). In Cordoba (not infected) the FPI is higher (0.74) than in infected areas of Puglia.

The overall value of **RISK index** (DKI/DPI/FPI) for the case study areas decreases as following: Puglia (I) 0.74 > Cordoba (NI) 0.47 > Alicante (I) 0.38 > Puglia (NI) 0.36; Crete (NI) 0.33 (**Figure 7**).

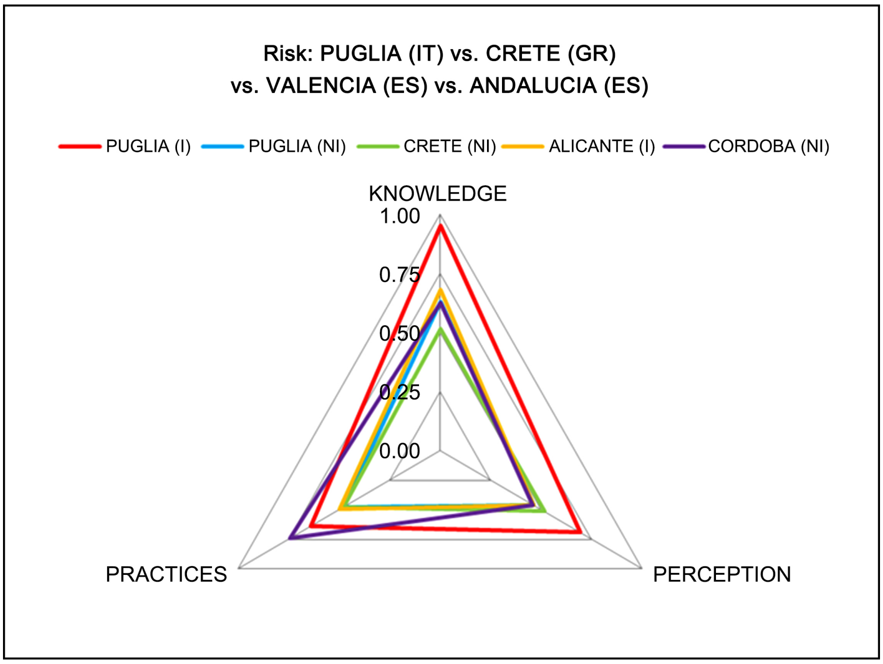


Figure 7. Risk domain's Indices (DKI/DPI/FPI): comparison among 5 groups of pilot areas (Puglia I, Puglia NI, Crete NI, Alicante I, Cordoba NI).

4.2.2. Governance Domain

Involvement (INV): respondents in Crete evaluated as high (0.73) their level of involvement in the management of disease. Interviewed in Puglia shows almost the same level of involvement (0.57 in not infected pilot areas and 0.61 in infected pilot areas).

The level of involvement is quite high (0.73 as average) in the province of Brindisi (along the Apulian containment's area) but decrease moving northward toward the municipalities of Foggia province (where INV is rated 0.53). In pilot areas falling into the Puglia infected zone, the level of INV is 0.61 (as average). Spanish pilot areas show a difference between infected (Alicante) and not infected (Cordoba) areas bigger than in Puglia: in fact, the level of involvement is rated 0.61 in Cordoba and 0.42 in Alicante.

Governance Effectiveness (EFF): was evaluated as very low (0.29) in infected pilot areas of Puglia (I); in general, the effectiveness of governance was rated lower in Puglia (0.33) than in Crete (0.50).

In particular, the level of trust in Public Authorities in managing the disease (evaluated on a 1 - 5 Likert scale) shows that in Puglia (both in infected and not infected areas) it ranks between very low/below average (1.73/5.00 and 2.05/5.00 respectively); then we will find not infected areas of Cordoba and infected areas of Alicante (2.71/5.00 and 2.79/5.00 respectively). In Crete (not infected) trustiness is significantly higher (3.20/5.00) but ranked around average (Figure 8).

Responsibility (RES): there are small differences in the level of knowledge about the roles in the management of disease between Puglia (both infected and

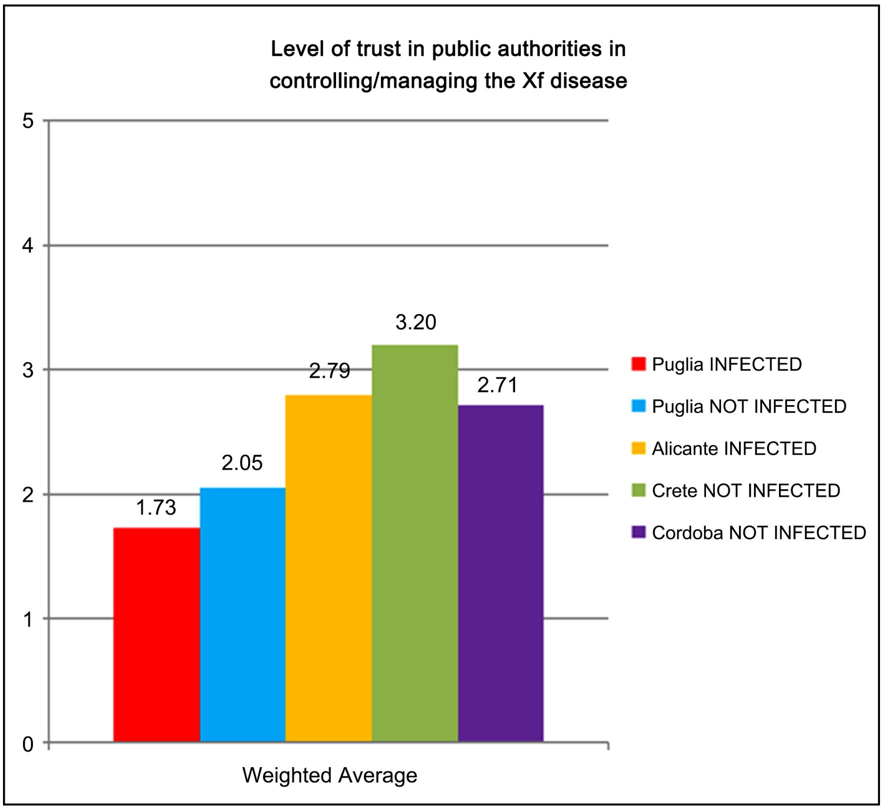


Figure 8. In the frame of EFF index, the level of trust (on a 1 to 5 scale) in Public Authorities in managing the Xf disease increase moving from the already affected areas to the not infected areas.

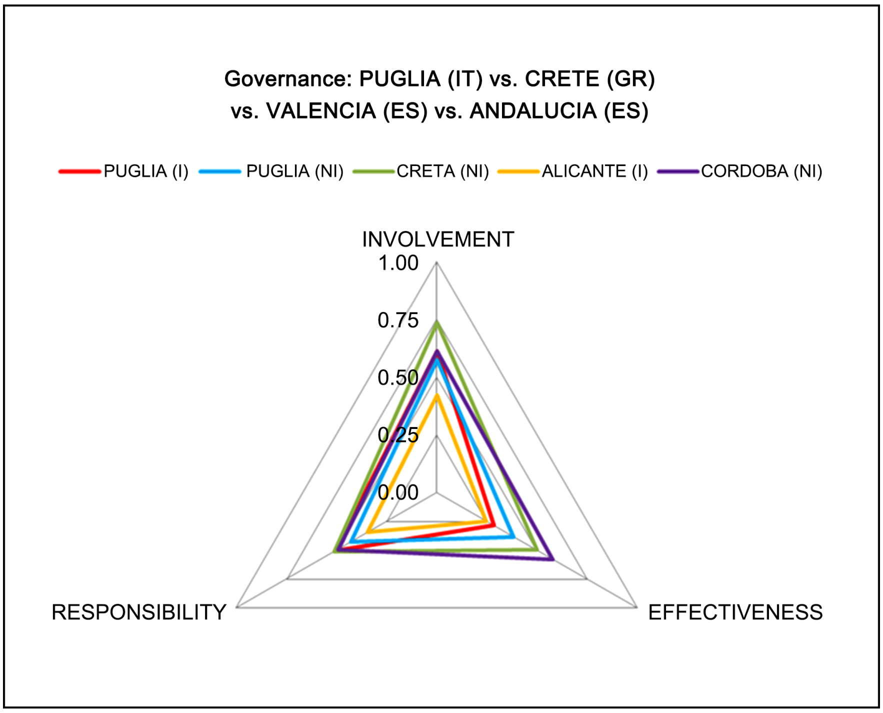


Figure 9. Governance domain's Indices (INV/EFF/RES): comparison among 5 groups of pilot areas (Puglia I, Puglia NI, Crete NI, Alicante I, Cordoba NI).

not infected) and Crete (not infected) (RES ranges from 0.43 to 0.51). While Cordoba (not infected) shows a RES value in line with other areas (0.49), such an index has a significantly lower value in Alicante (infected) where is rated at 0.34.

In general, the respondents show to have an unclear consciousness about the different responsibilities in the management of Xf.

The overall value for **GOVERNANCE index** (INV/EFF/RES) decreases as following: Crete (NI) 0.43 > Cordoba (NI) 0.41 > Puglia (NI) = Puglia (I) 0.27 > Alicante (I) 0.15 (**Figure 9**).

The value of the Governance index for Alicante (0.15) and therefore the evaluation of the involvement level, effectiveness of the prevention/containment actions and knowledge of the responsibilities in managing the disease is much lower than that found in the infected and not infected areas of Puglia (0.27).

As a general trend, governance seems to work less in areas where the phyto-sanitary emergency already occurred.

In conclusion:

- not infected areas of Puglia and Cordoba (Andalucia) shows a level of knowledge above the average (0.63), but the risk perception is below the average (0.46);
- not infected areas of Crete show values of DKI and DPI in line with the average (0.52 and 0.51 respectively);
- infected areas of Alicante (Valencia), although showing a quite higher level of knowledge (0.68) maintain the same perception level than the above mentioned not infected areas (0.46);
- infected areas in Puglia shows high level of knowledge (0.95) and perception (0.69);
- in all the municipalities in Puglia (both in infected and not infected areas) as well as in Andalucia, the respondents show a low level of trust (Governance index lower than 0.5);
- for Puglia, risk perception is higher in pilot areas included, or closer, to Infected Area (provinces of Lecce and Brindisi) and decreases moving far from the Infected Area (provinces of Foggia) northward; in Andalucia, indeed, also the risk perception is lower than the average;
- the municipalities of Crete (NI) show trust and risk perception closer to the municipality of Puglia far from Infected Area, this is more evident when compared to the municipalities of Puglia (I) showing low trust and high-risk perception.

4.3. Stakeholders' Attitudes

According to the Theory of Planned Behaviour (Ajzen, 1991), a person's intention to perform a particular behaviour follows from three determinants: attitude, subjective norms, and perceived behavioural control. Attitude toward the behaviour

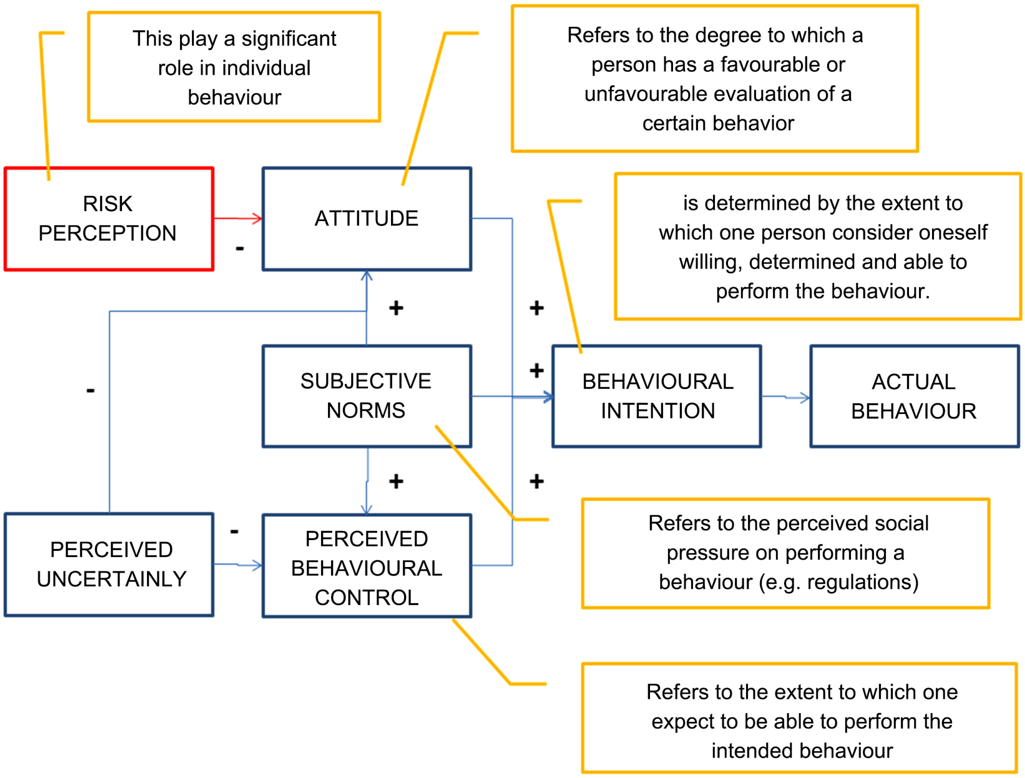


Figure 10. Theory of planned behaviour (adapted from Ajzen, 1991).

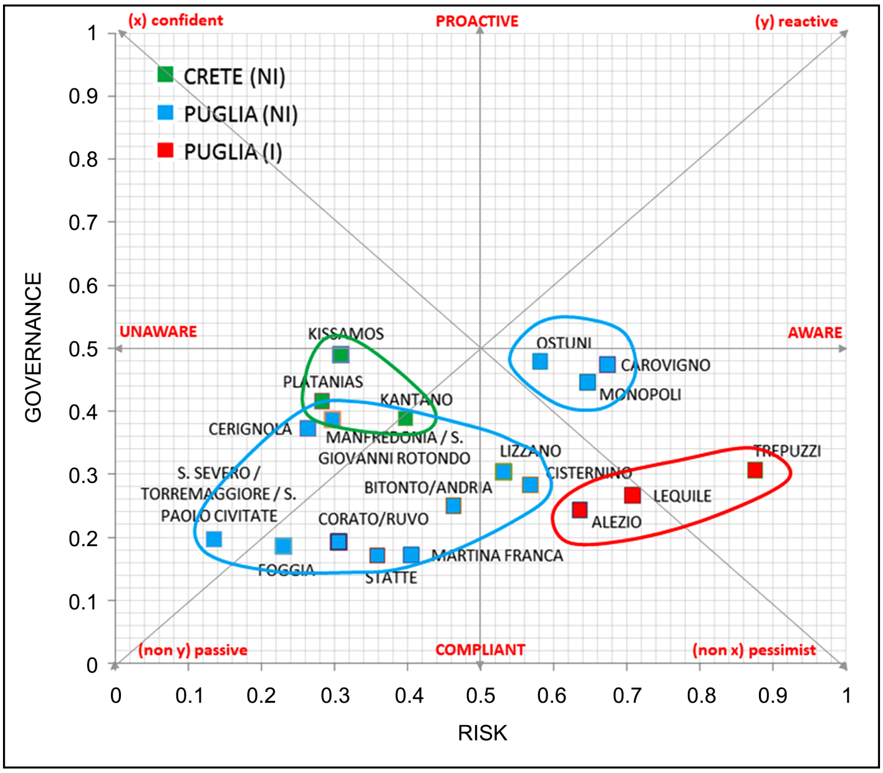
refers to the degree to which a person has a favourable or unfavourable evaluation of the behaviour in question. Subjective norm refers to the perceived social pressure on performing the behaviour (e.g., the existing containment rules). Finally, perceived behavioural control refers to the extent to which one expects to be able to perform the intended behaviour (Breukers et al., 2012).

In summary, behavioural intention is determined by the extent to which a person considers oneself willing, allowed, and able to perform the behaviour in question (**Figure 10**).

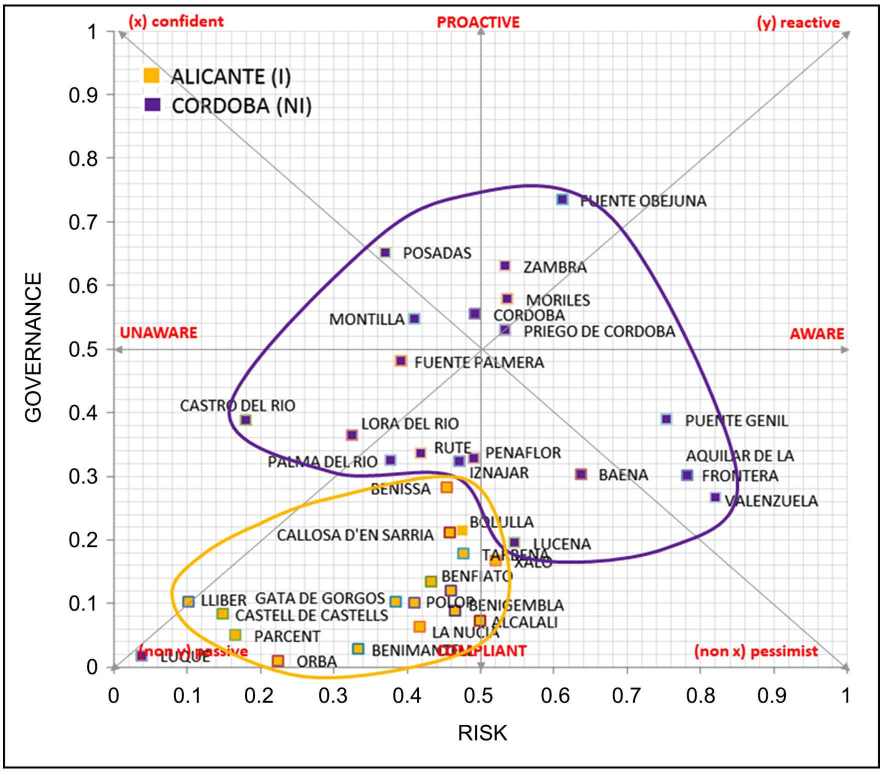
In our case, the behaviour of interest is "applying management measures on the farm to reduce invasive pathogen risk". In other words, attitude influences the coping strategies that the farmer intends to adopt to prevent/control/mitigate the disease and thus, his/her adaptative capability.

As stated before, among the factors affecting the success of a containment strategy, the farmers' level of risk perception, plays a relevant role. Farmers differ in the degree to which they accept and estimate risk. They base decisions (and, consequently, their adaptive capacity) on several factors. Some farmers are willing to accept more risk than others. Often farmers' attitudes regarding risk are based on their personal feelings (subjective knowledge) rather than information presented to them (objective knowledge) to help them make more rational decisions. This different risk perception influences their attitude.

Thus, we hypothesize that risk perception may have an indirect effect on farmers' behaviour, through their attitude. The reasoning behind this is that perceived



(a)



(b)

Figure 11. Graph representing the couple of Risk vs. Governance index for each Municipality in Puglia, Crete (a), Alicante and Cordoba (b). Grey axis and red sentences refer to the "semiotic square" classification of interviewed attitudes.

benefits of risk management measures (i.e., the governance effectiveness) and, thus, attitudes (intended as the willingness to adopt such measures) increase as the perceived risk increases.

In summary, in our hypothesis risk perception together with the subject evaluation of risk management effectiveness (governance) determine farmers' attitude and, consequently, their availability to adopt strategies able to improve their adaptative capability in facing the disease.

The different municipalities were plotted in a diagram with the average values of the RISK (x-axis) vs. GOVERNANCE (y-axis) domain's indices (**Figure 11(a)**, **Figure 11(b)**). By superimposing on the graph a semiotic square, built according to the Greimas' rules (Greimas, 1966), we can more easily identify categories of respondents' behavior (Ladisa, 2018).

Puglia (IT): Respondents belonging to the municipalities **far from the infected area** (province of Foggia) show a ***passive*** attitude described by a low-risk perception and a low level of trust in regional and/or national governance; on the contrary, the municipalities closer to the infected area (i.e., Containment and Buffer Areas, in Brindisi and in the south-eastern part of Bari), are more ***aware*** showing a medium-high perception of risk and a medium level of trust in the regional government. On the other hand, people interviewed in the municipalities **falling into Infected Area** (province of Lecce) show a more ***compliant*** attitude, because they already experienced the negative impacts of the disease on their productive activities and show little or no trust in the solutions and in the governance.

Crete (GR): Respondents from the municipalities in the province of Chania, present a more ***optimistic*** attitude, since they are aware of the risk and are confident in the prevention action implemented by the national authority.

Valencia and Andalucia (ES): Respondents **belonging to the Infected area** of Alicante (Valencia) reveals a ***passive-compliant*** attitude; while they show a risk perception lower than similar infected areas in Puglia ($0.38 < 0.74$) the governance appreciation is very low (0.15), similar (but lower) to the one detected in Puglia (both infected and not infected). Attitude of respondents in Cordoba province (NI) is more ***reactive*** with average risk perception and governance appreciation above average.

Differences in Spanish pilot areas could be due to the different conditions of farmers: in Alicante farmers are mainly part-time with family orchards with 100-200 trees having an average farm-size lower than 20 hectares. Almond is quite a marginal crop in term of profits and disease impacts are, so far, low.

This situation can explain the low level of risk perception (DPI) despite of a good level of disease knowledge (DKI) because of the intensive information programme carried on by the Comunidad Valenciana. Prevention/control measures are only tolerated with strong frictions and resistances, as demonstrated by frequent farmers' demonstrations.

In Cordoba farmers are more professional, with large extension of intensive (and super-intensive) crops (almonds, citrus, grapes). Even in this region, several information campaigns are carried on by different actors. Farmers are quite confident in applied control measures.

The analysis is consistent with what has been said about where and how to intervene to increase the level of trust and risk awareness.

Consequently, it can be clearly seen that:

- INFECTED pilot areas are characterised by a very high score in the RISK domain and a lower score in the GOVERNANCE; probably due to the lack of a clear and shared decision-making process. These combined effects could have hampered the application and the effectiveness of the containment measures in this zone. Governance seems to work less in areas where the disease already occurred.
- NOT INFECTED pilot areas are characterised by a lower score in the RISK domain and a slightly higher score for GOVERNANCE; this can be a very important hint to design intervention strategies able to respond to local people concerns, prevent reactions and building consensus about the application of containment measures. Where RISK perception is quite high (e.g., Cordoba NI), the proactive attitude of farmers can enhance the effectiveness of management practices.

4.4. Analysis of Data: Correlations among Indices/Indicators

To analyze results obtained from the survey, a correlation analysis has been carried out by using IBM-SPSS. Pearson's correlation index was applied to the six indicators in Risk and Governance domain with r varying from −1 to +1, (−1 = strong negative correlation; +1 = strong positive correlation).

Risk and **Governance** domain are statistically correlated (Table 4).

The high score observed in the Pearson's correlation (0.650**) indicates that there is a highly significant positive correlation among the indices of Involvement (INV), Effectiveness (EFF) and Responsibility (RES), meant as knowledge about roles and functions in the field of competences of disease management.

Thus, we can assume that when the involvement of stakeholders (INV) increases, the level of appreciation of governance effectiveness (EFF) and the awareness about roles and functions for disease management (RES) increases as well.

In order to answer questions related to the importance/relationship of the two domains (Risk/Governance) in reference to certain variables such as the "current situation" (Infected/Not Infected) as well as the "territorial context" (such as the country), further correlation analysis was performed.

Correlation seems to be higher in Not Infected areas (0.719**) than in the Infected areas (0.690**) as a whole (Table 5). In other words, there is an association of those domains with the level of infection observed in the specific area.

Table 4. Statistical correlation between Risk and Governance Indices (all the case study areas). (**) Correlation significant at 0.001 level (2-tailed).

Domain		RISK	GOVERNANCE
RISK	Pearson Corr. Sign. (2-tailed)	1	0.650** 0.000
	N	262	262
GOVERNANCE	Pearson Corr. Sign. (2-tailed)	0.650** 0.000	1
	N	262	262

Table 5. Statistical correlation between Risk and Governance Indices in the "Infected" and "Not Infected" areas. (**) Correlation significant at 0.001 level (2-tailed).

Situation	Domain		RISK	GOVERNANCE
INFECTED	RISK	Pearson Corr. Sign. (2-tailed)	1	0.690** 0.000
		N	59	59
	GOVERNANCE	Pearson Corr. Sign. (2-tailed)	0.690** 0.000	1
		N	59	59
NOT INFECTED	RISK	Pearson Corr. Sign. (2-tailed)	1	0.719** 0.000
		N	203	203
	GOVERNANCE	Pearson Corr. Sign. (2-tailed)	0.719** 0.000	1
		N	203	203

Then the correlation coefficient by Country and by current situation (Infected/Not Infected) was calculated (Table 6); this report a significant relationship between the two domains (Risk/Governance) in the Not Infected areas in Italy (0.829**), Spain (0.651**) and Greece (0.599**), while the ration is rather weak in the Infected areas of Italy (0.510**) and Spain (0.572**).

Correlation analysis was performed to examine the direction and strength of the association of our variables within the RISK and GOVERNANCE domains.

Correlation analysis among the indicators in the RISK domain shows a weak or moderate positive correlation among the Knowledge about the disease (DKI), the risk Perception (DPI) and the trust in the proposed Practices (FPI). The results suggest that the higher is the knowledge of disease (DKI), the more is the risk perception (DPI) and consequently the willingness to apply containment practices (FPI).

Correlation among the indices of Governance domain seems to be stronger in comparison to the Risk (Table 7). Correlation analysis among these indicators shows a positive moderate correlation among the indices of Involvement (INV), Effectiveness (EFF) and Responsibility, meant as knowledge about roles and functions in the field of competences of disease management (RES). The results suggest that when the involvement of stakeholders increases (INV), the level of appreciation of governance effectiveness (EFF) increase as

Table 6. Statistical correlation between Risk and Governance Indices by Country, in the "Infected" and "Not Infected" areas. (**) Correlation significant at 0.001 level (2-tailed).

Situation	Country	Domain		RISK	GOVERNANCE
INFECTED	ITALY	RISK	Pearson Corr.	1	0.510**
			Sign. (2-tailed)		0.005
			N	29	29
		GOVERNANCE	Pearson Corr.	0.510**	1
			Sign. (2-tailed)	0.005	
			N	29	29
	SPAIN	RISK	Pearson Corr.	1	0.572**
			Sign. (2-tailed)		0.001
			N	30	30
		GOVERNANCE	Pearson Corr.	0.572**	1
			Sign. (2-tailed)	0.001	
			N	30	30
NOT INFECTED	GREECE	RISK	Pearson Corr.	1	0.599**
			Sign. (2-tailed)		0.000
			N	30	30
		GOVERNANCE	Pearson Corr.	0.599**	1
			Sign. (2-tailed)	0.000	
			N	30	30
	ITALY	RISK	Pearson Corr.	1	0.829**
			Sign.		0.000
			N	120	120
		GOVERNANCE	Pearson Corr.	0.829**	1
			Sign. (2-tailed)	0.000	
			N	120	120
	SPAIN	RISK	Pearson Corr.	1	0.651**
			Sign. (2-tailed)		0.000
			N	53	53
		GOVERNANCE	Pearson Corr.	0.651**	1
			Sign. (2-tailed)	0.000	
			N	53	53

Table 7. Statistical correlation among indices of both the Risk and Governance domain (all case study areas) (**) Correlation significant at 0.001 level (2-tailed).

RISK	GOVERNANCE
FPI/DKI (0.242**)	INV/EFF (0.329**)
DKI/DPI (0.195**)	INV/RES (0.326**)
FPI/DPI (0.215**)	

Table 8. Statistical correlation among indices of both the Risk and Governance domain (all case study areas) (**) Correlation significant at 0.001 level (2-tailed).

INFECTED	NOT INFECTED
DKI/FPI (0.385**)	DKI/FPI (0.207**)
DKI/INV (0.355*)	DKI/INV (0.322**)
DKI/RES (0.281**)	DPI/INV (0.210**)
DPI/FPI (0.468**)	DPI/RES (0.219**)
DPI/INV (0.351)	FPI/INV (0.284**)
FPI/RES (0.413**)	FPI/EFF (0.415**)
	INV/EFF (0.317**)
	INV/RES (0.320**)

well, together with the awareness about roles and functions for disease management (RES).

Such stronger correlation among indices within the Governance domain, seems to be more evident in Not Infected areas (Table 8).

Talking about the Not Infected areas of Italy, it is worth mentioning the strong relationship between specific indices such as the Involvement (INV), the trust and willingness to adopt prevention/control/mitigation measures (FPI) and the appreciation of governance effectiveness (EFF) which may have some implications regarding the policy measures and the practices adopted for those areas.

To further investigate if specific characteristics of the interviewed stakeholders influence their perception in relation to the domains RISK and GOVERNANCE already identified, specific statistical tests (parametrical Independent t-test, and one-Way Analysis on Variance) were performed.

The **prevalent activity** (Table 9) of the stakeholder interviewed seems to influence the way he/she perceives the domain GOVERNANCE (t-stat −2.52 Sig. 0.011). On the contrary there is no association between the RISK domain and the activity of the person interviewed (t-stat −0.594 Sig. 0.55).

In terms of **education level**, GOVERNANCE index takes statistically (F-test 8,958 Sig. 0,000) higher values in the case of "Other" and "University level", while Primary, Preparatory and Secondary school appear as a joint group with reduced values of the Index (Table 10).

The **management system** applied from the person interviewed (Table 11)

Table 9. Prevalent activity of the interviewed stakeholders.

Group Statistics					
Group of Activities		N	Mean	Std. Deviation	Std. Error Mean
RISK	Farmer	188	0.4546442414	0.21793119534	0.01589426598
	Other	74	0.4717046010	0.18542044089	0.02155468843
GOVERNANCE	Farmer	188	0.2422850536	0.14535031980	0.01060076158
	Other	74	0.2945519000	0.15616109175	0.01815335818

Table 10. T-test: Education level of interviewed stakeholders.

GOVERNANCE			
Tukey B a,b			
Education level	N	Subset for alpha = 0.05	
		1	2
Primary school	32	0.1934261765	
Preparatory school	34	0.2058423093	
Secondary school	129	0.2434820244	
Other (specify)	36		0.3232334432
University	31		0.3584699810

Means for groups in homogeneous subsets are displayed; a. Uses Harmonic Mean Sample Size = 17.141; b. The group sizes are unequal. The harmonic mean of the group sizes is used; Type I error levels are not guaranteed.

Table 11. T-test: management system in stakeholders' farm/firm.

GOVERNANCE			
Tukey B a,b			
Management system	N	Subset for alpha = 0.05	
		1	2
Organic	52	0.2237317100	
Conventional	171	0.2616159850	0.2616159850
Integrated	26		0.3195534220

Means for groups in homogeneous subsets are displayed; a. Uses Harmonic Mean Sample Size = 17.141; b. The group sizes are unequal. The harmonic mean of the group sizes is used; Type I error levels are not guaranteed.

seems play a role in the way he/she perceives Involvement (INV), Effectiveness (EFF) and Responsibility (RES) (F 3.620, Sig 0.0280). Stakeholders following "integrated" cultivation techniques seem to differentiate from the others because it appears to get higher score in the domain of GOVERNANCE. The latter case is quite disputable, given the possible uncertainty or ambiguity in defining a management system as truly "integrated". On the other hand, there is no statistical significance in the mean values of RISK in relation to the management system (F 0.912, Sig 0.403).

The One-way ANOVA test indicates that the perception of the RISK changes in terms of the **Country** of the person interviewed. More specifically the RISK index takes higher values (F: 9.029 and Sig: 0.000) in both Italy and Spain while it takes lower value in the case of Greece (Table 12).

There is no statistical significance in the mean values of GOVERNMENT in reference to the "country" factor (F 0.478, Sig 0.620).

In terms of the **current situation** (Infected, Not Infected), the RISK index takes the higher statistically significant values in the case of INFECTED areas (t-stat: 5.048, Sig: 0.000). Thus, there is a significant differentiation in the Knowledge about the disease (DKI), the risk perception (DPI) and the trust of the proposed practices (FPI). While there is no statistical significance (t-stat: 1.341, Sig: 0.181) in the GOVERNMENT domain indicating that the means of this domain are equal in both Infected and Not Infected areas. Thus, there is no difference in the way that stakeholders perceive this domain in the Infected and Not Infected areas (Table 13).

The One-way ANOVA test indicates that the perception of the RISK and GOVERNANCE changes in terms of the Region of the person interviewed (F:

Table 12. T-test: Country of interviewed stakeholders.

RISK			
Tukey $B_{a,b}$			
Country	N	Subset for alpha = 0.05	
		1	2
GREECE	30	0.3295028813	
SPAIN	83		0.4398659518
ITALY	149		0.4965456203

Means for groups in homogeneous subsets are displayed; a. Uses Harmonic Mean Sample Size = 17.141; b. The group sizes are unequal. The harmonic mean of the group sizes is used; Type I error levels are not guaranteed.

Table 13. Correlation of Domain (Risk/Governance) indices with current situation (all case study areas).

Group Statistics					
Situation		N	Mean	Std. Deviation	Std. Error Mean
RISK	INFECTED	59	0.5750955195	0.24342575846	0.03169133440
	NOT INFECTED	203	0.4258552818	0.18550984193	0.01302023841
GOVERNANCE	INFECTED	59	0.2340175896	0.16609108168	0.02162321705
	NOT INFECTED	203	0.2637408517	0.14480378096	0.01016323302

Table 14. Correlation of Risk index with Region of interviewed stakeholders.

RISK			
Tukey B a,b			
Region	N	Subset for alpha = 0.05	
		1	2
CRETE	30	0.3295028813	
VALENCIA	30	0.4092015077	0.4092015077
ANDALUCIA	53		0.4572231843
PUGLIA	149		0.4965456203

Means for groups in homogeneous subsets are displayed; a. Uses Harmonic Mean Sample Size = 17.141; b. The group sizes are unequal. The harmonic mean of the group sizes is used; Type I error levels are not guaranteed.

Table 15. Correlation of Governance index with Region of interviewed stakeholders.

GOVERNANCE				
Tukey B a,b				
Region	N	Subset for alpha = 0.05		
		1	2	3
VALENCIA	30	0.1447026975		
CRETE	30		0.2498303711	
PUGLIA	149		0.2510770050	
ANDALUCIA	53			0.3415087714

Means for groups in homogeneous subsets are displayed; a. Uses Harmonic Mean Sample Size = 17.141; b. The group sizes are unequal. The harmonic mean of the group sizes is used; Type I error levels are not guaranteed.

6.379, Sig: 0.00). More specifically the RISK index takes higher values in the areas of Italy and Spain while it takes lower value in Crete-Greece (Table 14).

While in the case of Governance index, lower values are observed in Spain for the region of VALENCIA (Alicante) (F: 12.8 Sig 0.00) in comparison to the other area of ANDALUCIA (Cordoba) (Table 15).

4.5. Results and Trends

The perception of Risk (DKI/DPI/FPI) does not change in function of the characteristics of the stakeholders.

The risk perception is higher in pilot areas included, or closer, to Infected Area (e.g., provinces of Lecce and Brindisi in Puglia) and decreases moving far from the Infected Area.

As previously illustrated, RISK domain's indicators (DKI, DPI and FPI) shows a moderate positive correlation, suggesting that the higher is the knowledge of disease (DKI), the more is the risk perception (DPI).

Nevertheless, going deeper in the analysis in the different areas (Puglia, Crete, Valencia and Andalucia), it is possible to see how, not in every case, knowledge is so closely correlated with risk perception.

Although the disease knowledge is very high in Puglia Infected Areas (IA), in these areas the risk perception is lower than the expectation probably because farmers already experienced the presence of Xylella. Therefore, in their case, rather than the "likelihood" of being subjected to the problem, they were more prone to express an evaluation of impacts of the disease on their productive activity.

In the Apulian pilot areas falling into Containment Area (CA) as well as in the Buffer Area (BA), a high-level Knowledge (DKI) about the disease is not linked to a real capacity to quantify the risk (DPI) and to the willingness to apply any measure (FPI).

In the Xf-Free Area (FA), especially in the north of Puglia, both the level of knowledge and the risk perception are low. Such a low-risk perception may be the expression of an unrealistic optimism (already reported as "denial" in literature by Weinstein, 1987).

The municipalities of Crete (NI) show a level of knowledge higher than the not infected municipalities in the province of Foggia, although the risk perception is quite the same of the municipality of Puglia far from Infected Area. The low-risk perception could be explained by the high trustiness in the measures adopted by national government in preventing the disease.

The collected data for the Spanish target areas shows that a quite high proportion of respondents of Cordoba (not infected) have values of risk and governance indices above the average (0.50). Several information campaigns are carried on by different actors and thus farmers are quite confident in applied control measures.

On the opposite, almost all pilot areas falling into the Alicante's province (infected) show both risk and Governance indices below the average and, sometimes, very low. Despite of the intensive information programme carried on by the Comunidad Valenciana, that can explain the sufficient level of disease knowledge (DKI), the level of risk perception (DPI) is low. In this area prevention/control measures are only tolerated with strong frictions and resistances.

4.6. Causation among Domains and Indicators

In order to investigate linkages between Governance and Risk (perception and management) domains as well as among their indices, Structural Equation Modeling (SEM) technique was adopted (Schumacker et al., 2004). SEM allows multivariate statistical analysis which makes it possible to analyze linear relationships between variables from the analysis of the covariance among the variables.

SEM methods, in comparison with classical approaches such as linear regression, allow one to simultaneously analyze several types of interrelationships between variables in an experiment. Variables can be directly observable (as in this case) or indirectly observable (latent), that is, variables that are inferred from multiple indicators. In particular:

- Variables may be directly or indirectly related. For example, the effect of A on C may be direct, (A → C), or it may be indirect or mediated by B, (A → B → C). SEM can distinguish direct from indirect relations.
- A relation between variables may be recursive. That is, the effect of A on B, (A → B), may be different from the effect of B on A, (B → A).
- Any variable in a SEM model may simultaneously act as an independent and a dependent variable, i.e., each indicator can both influences, and be affected by, other indicator in the model.

The nature of the relation between variables is given by the regression coefficient (β); it describes how much the dependent variable changes when an independent variable changes by one unit. SEM directly integrates the errors of measurement into a statistical model; by doing so, the estimates of regression coefficients are more precise than they are with classical methods such as multiple regression, factorial analysis, analysis of variance or discriminant analysis.

As reported in Figure 12, Figure 13 and Figure 14 the arrows direction indicates the hypothesized and tested relations between the involved indicators; the more the line thickness is, the lowest is the tested level of significance

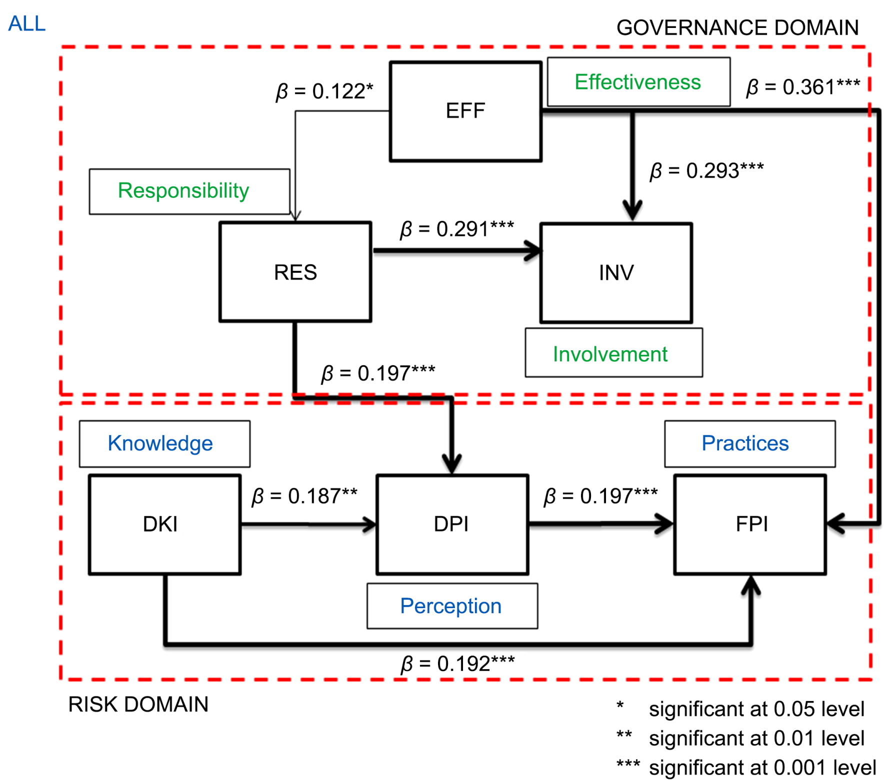


Figure 12. SEM model among indices and domains: the whole sample (263 questionnaires).

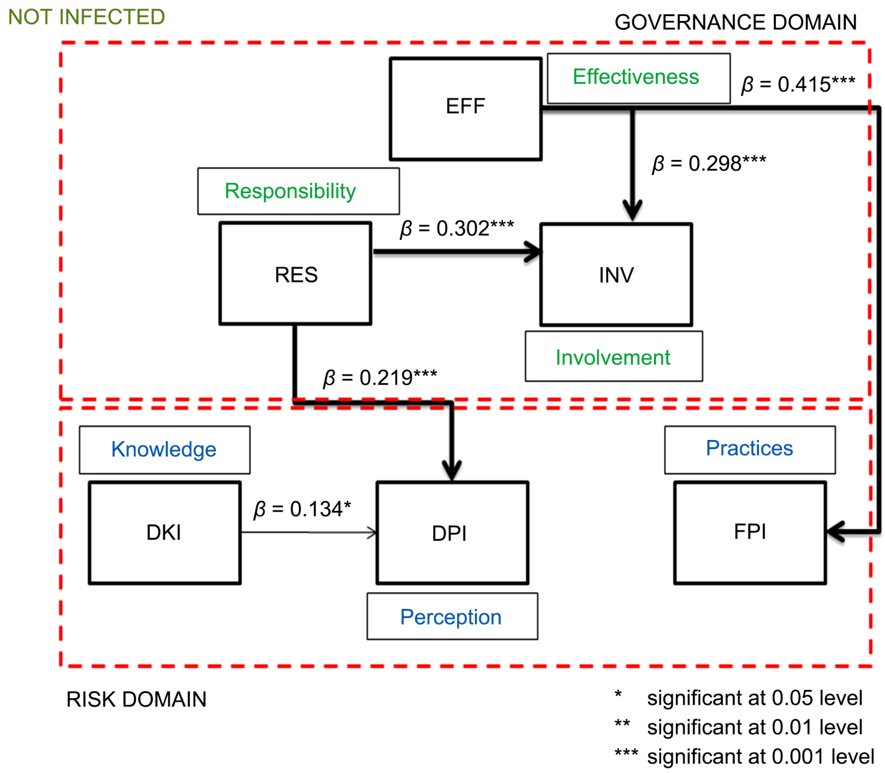


Figure 13. SEM model among indices and domains: Not Infected areas (Puglia, Crete, Andalucia) (203 questionnaires).

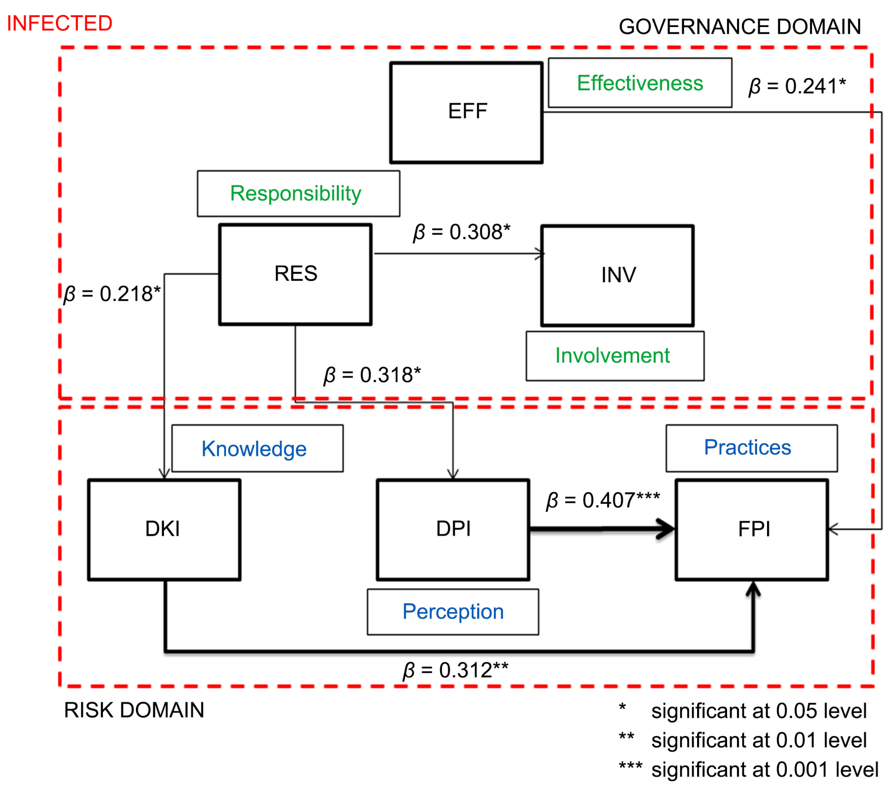


Figure 14. SEM model among indices and domains: Infected areas (Puglia, Valencia) (60 questionnaires).

(* significant at 0.05 level; ** significant at 0.01 level; *** significant at 0.001 level).

Causation analysis shows that:

- There are linkages between Governance and Risk (management and perception) domains as well as among some of their indices (**Figure 12**).
- The level of stakeholders' involvement (INV) is influenced both by the governance effectiveness (RES) and the knowledge of the responsibility chain (RES).
- The availability to implement farm practices (FPI) is influenced both from the objective level of knowledge (DKI) as well as from the subjective perception of the risk (DPI). In turn, the level of knowledge of the disease influences the perception of the risk.
- The level of consciousness about the different levels of responsibility influences the perception of the risk (DPI).
- According to the statements above, the implementation of practices (FPI) could be sustained 1) by acting in more effective implementation of rules and 2) by increasing the level of perception of stakeholders.

The statements above are confirmed both for the whole sample (**Figure 12**), as well as for Not Infected countries (**Figure 13**). In the latter, knowledge influences perception but the implementation of practices is mainly supported by effective governance.

In Infected countries (**Figure 14**):

- It is confirmed that, in the implementation of practices (FPI) the perception of the disease (DPI) plays a more relevant role than of the objective Knowledge of it (DKI).
- Both objective knowledge (DKI) and subjective perception (DPI) can be improved by increase the level of responsibility (RES).
- The governance effectiveness directly acts on the level of implementation of practices but seems that the overall influence of Governance on risk is weak in infected areas. Governance seems to work less in areas where the disease already occurred.

5. Conclusion

The proposed methodology and the related survey can describe attitudes of respondents in facing the epidemic and their level of appreciation of disease management. It could provide practical suggestions on intervention aimed to improve knowledge-perception relationship that directly influences the willingness to adopt preventive/control measures against the pathogen and thus the vulnerability of a given territory (McCarthy et al., 2001).

From the analysis of correlation carried out on the whole survey's results, we gathered some general indications useful to propose general but important suggestions to improve the efficiency of the governance systems in relation to the containment of Xf related disease.

Suggested indicators as well as domains' indexes (RISK and GOVERNANCE) show to be statistically **well correlated**.

SEM analysis among both domains of GOVERNANCE and RISK highlights a degree of relationship between the involvement (INV), adoption of practices (FPI) and responsibility (RES); it is possible to activate a positive feedback about the efficacy of governance and the application of practices **by directly involving stakeholders**. Such initiative could increase the knowledge about role and function of the players involved in disease management.

The positive correlation among the indicators of KNOWLEDGE, PERCEPTION and adoption of PRACTICES suggests improving the Stakeholders' knowledge about pathogen and vectors, symptoms, transmission and spread, to increase the acceptability and the willingness to adopt prevention and control practices. Stakeholders ask for **more effective information** about the real risk level and about good practices for prevention, containment, and mitigation.

The positive correlation among the indicators in the GOVERNANCE domain among INVOLVEMENT, EFFECTIVENESS and the knowledge about RESPONSIBILITY suggests that it is important, while improving the level of involvement of farmers/stakeholders, **to clarify the different roles and responsibilities** in the management of the disease. Respondents indicate meetings with farmers' organizations and focus groups as the best ways to be involved in the governance process.

The key components for more effective risk governance are the engagement of stakeholders, the involvement of expert groups and an appropriate communication strategy. However, differences are present in the scale of stakeholder engagement (widespread and diffuse versus narrow and focused), the type and range of experts and the communication channels used.

To achieve a more effective communication about Xf, based on the survey's results, some "Communities of Practices (CoP)[4]" were build (the first one in Puglia). Such a CoP grouped together stakeholders (farmers, practitioners, producers' representatives, members of Regional Phyto-sanitary Authority) to share their experiences as well as the strategies carried on in facing the disease, to improve the knowledge-transfer process.

After more than 7 years from the first finding of Xf in Apulia, based on the current experience and situation, it is advisable to implement the phytosanitary measures by enlarging the discussions and consultations to other parties: i.e., economic, political, and social. In practice, this would help the acceptance of the containment measures which would not be perceived as compulsory actions enforced by the competent Authorities but as a process jointly built to fight the emergence. Indeed, communication between government and stake-

[4]Etienne Wenger (Leave & Wenger, 1991) summarizes Communities of Practice (CoP) as "*groups of people who share a concern or a passion for something they do and learn how to do it better as they interact regularly*." This learning that takes place is not necessarily intentional. The purpose of a CoP is to provide a way for practitioners to share tips and best practices, ask questions of their colleagues, and provide support for each other.

holder groups should have been more intense to ensure successful implementation of the policy outcomes. The present work is now being extended to other case studies and sensitive crops (Cardone et Al., 2021, in press).

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Conflicts of Interest

The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

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