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Multi-criteria evaluation model to face phytosanitary emergencies: The case of citrus fruits farming in Italy

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Abstract: In the last decade, citrus fruits farming, at the international level, revealed an upward trend changing the traditional scenarios of the offer, with the exchange of products coming from all areas of the world, thanks to the progressive abrogation of fare barriers. The material exchange is causing spreading of diseases that have caused a severe damage, such as the epidemics and culture extinctions with a high economic, health, environmental and social impact. In such a context, the definition of possible methods to face the emergencies is absolutely necessary. This research suggests the adoption of an evaluation model for phytosanitary emergencies (Citrus Tristeza Virus – CTV), a model that is sustainable from the economic, social, biotic and phytosanitary perspective. It is based on an integrated model that considers the application of a participatory planning technique and of an evaluation method included among the tools of the Social Multi-Criteria Evaluation (SMCE). The results highlighted that the hypothesis 1 "cohabitation with the Citrus Tristeza virus" is the predominant hypothesis, followed at short distance by the hypothesis 2 "total eradication and re-implantation", while the hypothesis 3 "abandonment or extirpation" gained a marginal meaning. It was possible to assert that the hypothesis 1 was the one that presented the highest sustainability.

Keywords: economic, planning, Citrus Tristeza Virus, social choice, NAIADE method, social multi-criteria evaluation (SMCE)

In the last decade, the citrus fruits farming at the international level has experienced an upward trend that has modified the traditional scenarios of the offer, that have been characterized by an increase in the surface involved in the South and Central America, North Africa and Asia, thanks to the upgrade of the production techniques on the field, the evolution of logistics, the abolition and reduction of fare barriers with the exchange of goods and vegetable products from all areas of the world. The exchange of goods is causing spreading of diseases that means a limited damage in the area of origin, while in other countries, characterized by different pedoclimatic conditions, is causing epidemics, culture extinction, affecting the economy, health, environment and society. In such a context, the definition of the possible methods to face the phytosanitary emergencies is absolutely necessary. This research suggests the adoption of an evaluation model for the phytosanitary emergencies, a model that is sustainable from the economic, social, biotic and phytosanitary perspective, to be applied to different species and other citrus fruits farming areas. It is an integrated model that considers the application of a participatory planning technique and of an evaluation method to collect the opinions of stakeholders, included among the tools of the Social Multi-Criteria Evaluation (SMCE).

The whole volume of citrus fruits produced at the world level in the four-year period 2010/1013 was of 131 million tons (FAO 2015), with a 16% increase in the last decade. The main producer countries of the Mediterranean, instead, at the European Community level (EC), showed to be stable, with the outstanding Spain, while on the other shore of the Mediterranean, an increase of the production volumes was registered, among which Egypt equalled Italy (Carra et al. 2014). In such a context, the Italian citrus fruits farming with almost 3.1 million tons of productions (2010/2013) on a surface of 152 thousand hectares in a constant reduction (ISTAT 2015), is experiencing a time of crisis.

At the national level, we registered a downward trend of investments into the citrus fruits farming, as a consequence of the unfavourable trend of the related product market (Sturiale 2006; Scuderi et al. 2011; Tudisca et al. 2014).

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In Italy, in the range of time between 1991 and 2013, since the abatement of phytosanitary barriers (1992) up to today (Chinnici et al. 2013), the investments in citrus fruits farming have reduced from about 182 thousand hectares to 152 thousand hectares with a reduction of over 16%.

The evolution of the social-economic system, the orientation changes of the agricultural policy, especially in the European Union, the market globalization, the evident asymmetries of costs within the sector among the different countries at a different level of development and much more, have contributed to eroding of the primary role of citrus fruits farming in the island, causing fluctuating income levels with the unevenness both among different species and different areas of cultivation (Carra et al. 2014; Tudisca et al. 2014; Scuderi et al. 2015a).

In such a scenario, the national citrus fruits sector has been negatively affected. More agreeable strategies need to be defined and applied among the market actors, considering that on one side, a structural unbalance between the offer and the demand arises, especially at the time of crisis, and that, on the other side, the competition comes from the citrus fruits producer countries that have a general system of prices much lower that the Italian system - North Africa countries, South-America countries, South Africa ones – since their costs along the production process are clearly lower than those born by our operators (Carra et al. 2014; Scuderi et al. 2015b).

To make the situation worse, here comes the "*Citrus Tristeza virus*" (*CTV),* affecting almost the entire territory of Italy, with spotted focuses where the disease has spread more.

Besides this menace, which is a reality today, there are other diseases that are destroying citrus fruits cultivations in some areas of the world, such as the Black Spot (South Africa) and the Citrus Greening – HLB (USA) (Moreno et al. 2008).

The CTV is causing disastrous epidemics that have changed the citrus fruits production trend worldwide. Up to the present, the CTV infections have caused a loss of more than 250 thousand hectares of citrus fruits, 50% of which in the Mediterranean countries. The risk of a further devastation is still high, since the mainly used rootstock in these areas since the long time was the sour orange tree, which is very sensitive to the CTV (Moreno et al. 2008; Davino et al. 2013; Catara et al. 2006). In different areas of the world, great losses were registered due to the combination of the CTV variants that are very aggressive on different stock-rootstocks causing different syndromes known as quick decline, stem pitting and seedling yellows. According to this, it is clear that the implementation of models to face the phytosanitary emergency for *Citrus Tristeza Virus* in Sicily, gains a strategic meaning for citrus fruits farming, in a very complex area, from an environmental, socio-economic and institutional point of view, in which different actors with different goals are involved. Solutions may be obtained only by a common participation of all actors involved (Sorrentino et al. 2005; Davino et al. 2013).

Within the international scenario, almost all citrus fruits producer countries have experienced the problem of *Citrus Tristeza Virus,* and applied control strategies of many kind, according to the structural and phyto-pathological variables, ranging from the "total eradication model", as applied in Spain, Florida and Morocco, to the "disease cohabitation models" with specific cultivation techniques, which have been already used in California and also in Spain (Yokomi 2009). This variegated scenario confirms that an optimal unique strategy has not existed so far, in relation to the current variables. The involvement of stakeholders become more and more important and strategic in the decision-making process at the local level (Cihelková 2012; Stojanová and Tomšík 2014). Also, the qualitative evaluation of the information gathered among the actors involved, by the means of the multi-criteria analysis, is a key point to decide what actions are to be undertaken (Munda et al. 1994). This work, through the method of the participatory planning on one side, and the SMCE tool on the other side, aims at defining the hypothesis of an evaluation model that can be applied in other similar situations and other virus species.

MATERIAL AND METHODS

The proposed methodology is based on an integrated approach among the techniques of participatory planning, based on the creation of a focus group with different stakeholders, and the NAIADE method for the multi-criteria social evaluation – SMCE – of the complex information collected both the quantity- and quality-related (Matarazzo and Mundo 2001; Greco et al. 2010).

The target is that of developing a methodological structure made by suitable tools to acquire first, and to process second, the qualitative and quantitative information concerning the possible alternative

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scenarios of the problem under study. Opinions were collected at specific meetings at the local level with the stakeholders and sector's operators involved into the issue from the phytosanitary, economic-social and environmental points of view.

This is an approach that literature has widely adopted to deal with the problems related to territorial planning (Stratigea et al. 2013), but that we deemed suitable for the problem under study, characterized by a complexity of stakeholders involved and different scenarios, with not only the phytosanitary impacts but also the economic, social and environmental ones. Literature shows few studies carried out in the agriculture field that have adopted the SMCE-based tools (Panell and Glenn 2000; Vargas Isaza 2005; Siciliano 2009), while more are the articles that used the SMCE to solve problems bound to the management of water resources and environmental resources, in general, and sustainability, climate and energy politics (De Marchi et al. 2000; Munda 2007; Munda and Russi 2005, 2008; Munaretto et al. 2014).

The Figure 1 identifies the steps on which our SMCE is based on, with some adaptation in relation to the specificity of the context surveyed.

In details, the proposed model is based on:

– the individuation of the stakeholders involved
– the definition of alternative scenarios.

The definition of the evaluation context, that is, the decision criteria, the evaluation of the impact deriving from the application to alternative scenarios related to the criteria here dealt, and the final creation of the impact matrix.

The use of focus groups as a method for social research, to acquire the information concerning the opinions of stakeholders or social actors, according to Munda (2004), about the variety of scenarios for future development in the area under study.

This will help collecting information concerning the different interests during the evaluation phase of the action planning activities with the creation of a matrix of equity;

– impact and equity matrixes, which are the base for the use of the NAIADE multi-criteria evaluation discreet model (Novel Approach to Imprecise Assessment and Decision Environments) (Munda 1995), that can process the quantitative and qualitative data for the evaluation of the intervention measures. This tool supports: the classification of alternative scenarios proposed according to the specific decisional criteria and the consideration of possible "alliances" and "conflicts" among the stakeholder groups concerning said scenarios, and measuring their acceptability.

The active approach: the focus groups

The entire process was divided into three steps for the specific case of *Citrus Tristeza Virus*-infected citrus fruits yards:

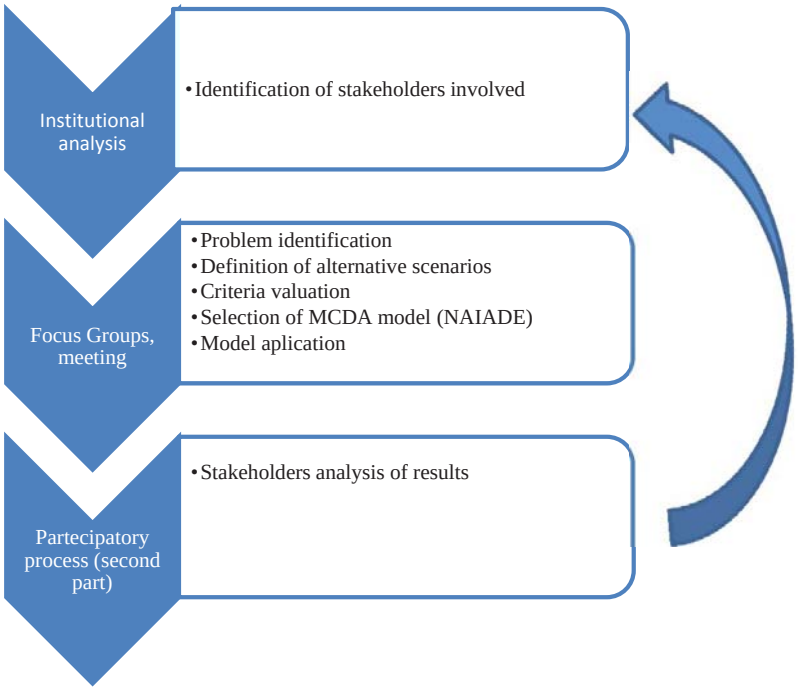

Figure 1 The theoretic structure of the SMACE model

Source: own observation; Munda (2004)

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Step 1: Meeting planning.

During this step, there was decided:

– the number of sessions and the duration: 8 sessions, one per category, 4–8 hours each;
– the presence of a guide to lead the interview: scientific and educational material concerning phytosanitary issues;
– the selection of participants: a stratified selection to create homogeneous groups;

Step 2: Carrying out the activities, based on the interview guide. It started with the presentation of the issue related to the action strategy to manage the *CTV*, using supporting material, such as articles, results, pictures, made up together specifically to introduce the subject under study and to stimulate the discussion and interaction among participants.

During this phase, different ideas and opinions were acquired, which represented the reactions of the participants involved into the issues dealt.

Step 3: Elaboration of the "qualitative results" and editing of the final report.

For the qualitative analysis, different tools were adopted, based on ad hoc inputs and specific rules. On the whole, the focus groups were considered social experiments, that could provide collective opinions, reveal communication barriers, study the conflict behaviour, acquire local information, create acceptable options, synthesize information, etc. (Morgan 1998). The key advantage of the dedicated focus groups to define the intervention strategies to face the *CTV*, compared to other participatory techniques, relies in the deep interaction among the participants, which become a social network (Bruggeman 2008). The participants become fundamental to support the "reciprocal learning process" about the examined issue. This participatory facing technique allows revealing new dimensions of the problem under study, highlighting the possibility for the focus groups to point out opinions rather than to provide results in general.

The NAIADE method

The multi-criteria NAIADE method applied to this study is a discreet evaluation method that can process qualitative and quantitative data. It is a tool suitable to plan how to deal with the problems characterized by a big uncertainty or complexity concerning the existing territorial, social and economic structures and their interactions (Munda 1995, 2006; Munda et al. 1994). The basic input of the NAIADE method is made of: alternative scenarios to be analysed, different decisional criteria for the relative evaluation, and different stakeholders who provide opinions about the scenarios under study. Based on this method, two kinds of analysis can be carried out (JRC 1996):

– a *multi-criteria analysis,* which, based on the impact matrix, leads to the definition of the priorities of the alternative scenarios concerning specific decisional criteria;
– an *equity analysis,* which, based on the equity matrix, analyses the possible alliances and conflicts of interests in relation to the scenarios under study (Torrieri et al. 2002; Soderberg and Karman 2003; Tiwari 2007; Shmelev and Rodriguez-Labajos 2009).

The basic input of the NAIADE method is the equity matrix (criteria/alternative matrix), which includes scores of different kind: crisp numbers, stochastic elements, fuzzy elements and linguistic elements, such as "good", "medium", etc.) (Munda 1995; JRC 1996). To compare the alternative scenarios, the concept of distance was introduced. If there are crisp numbers, the distance between two alternative scenarios regarding a specific evaluation criterion is calculated by subtracting the respective crisp numbers. In all other cases, the concept of the semantic distance is used, by measuring the distance between two functions through which the scores of the alternative scenarios result.

The Classification of the alternative scenarios is based on the impact matrix data, used to (JRC 1996):

– compare each single couple of alternatives for all the evaluation criteria considered;
– calculate a credibility index for each of these comparisons, which measures the credibility of a preference "... the alternative scenario «a» is better/worst, etc. ... than alternative scenario «b» ... (6 preferences are used);
– aggregate the credibility indexes produced in the previous step resulting into an intensity index of preference $\mu^*(a, b)$ of an alternative «a» instead of a «b» for all evaluation criteria, combined with the concept of entropy $H^*(a, b)$, as an indication of the variation of the credibility indexes;
– classify the alternative scenarios according to the previous information.

The final classification of the alternatives is the result (intersection) of two different classifications classification $\Phi^+(a)$ based on the preferences "better"

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and "definitely better" and the classification Φ^- (b) based on the preferences "worst" and "definitely worst".

According to the goal of this study, the main priority analysis will be applied for the definition of the best management model to control, monitor and eradicate the *CTV*.

Sicily is the application territory, for its high citrus fruits farming vocation, except for the lemon-growing lands, which are *CTV*-tolerant.

RESULTS

The multi-criteria analysis was carried out based on the following query:

Which are the strategies to keep growing citrus fruits in presence of the Citrus Tristeza Virus?

Three are the possible scenarios:

– ***hypothesis 1 – PROG***: cohabitation with the CTV and progressive eradication;
– ***hypothesis 2 – TOTAL***: total eradication and reimplantation;
– ***hypothesis 3 – FULL***: eradication and abandonment of citrus yards.

To assess the three above-reported hypotheses, specific elevation criteria were designed "... a measurable evaluation element *that may characterize a dimension of the different possibilities of choice considered"* (Voogd 1983). In this case study, twenty-one evaluation criteria or variables were used. Such criteria were designed according to the goals of the evaluation of the case analysed, that can represent the Sicilian citrus fruits reality involved in this important pathological emergency and the related phytosanitary actions to be undertaken.

The goals of the evaluation activity are of four kinds: Biotic, Social, Economic, Phytosanitary.

Specifically, here are reported for each goal the relative criteria of evaluation:

(a) biotic goal: soil, vocation, altimetry, water, climate;
(b) social goal: number of the sector's operators, job specialization, population/sector's operators ratio, levels of activity;
(c) economic goal: production, prices, gross sellable production, variable production costs, unit production costs, gross income, productivity in presence of the *CTV*, definition of economic measures supporting the *CTV*-affected citrus yards;
(d) phytosanitary goal: presence of the *CTV* in the area, spreading of *CTV*, monitoring actions and their characterization, spreading of other diseases.

According to the above-reported indicators, the impact matrix results, on their whole, are reported in the Table 1.

Hypothesis 1 PROG, as an option to be shared (highlighting the economic and social results), followed by the hypothesis 2 TOTAL (highlighting the social aspect) and, then the hypothesis 3 FULL (negative evaluation).

Then the equity matrix was developed. It provided the stakeholders' opinions on the three hypotheses suggested. The selection of stakeholders was based on their potentialities to influence the targets of the project, in the *CTV* case. The stakeholders here included belonged to the citrus fruits sector at different levels and with different qualifications, both into the private and public. In particular, 8 typologies of stakeholders were involved: producers, cooperatives, commercial operators, processing industry, tertiary sector's companies. It is important to underline that the stakeholders' opinions in the NAIADE model can only be of a quality kind: language expressions

Table 1. Impact matrix results on the whole

Criteria of evaluation	Hypothesis		
	1	2	3
Biotic	good	very good	poor
Social	very good	excellent	very poor
Economics	good	excellent	poor
Phytosanitary	very good	very good	medium

Source: own observation, data collected direct survey

Table 2. The equity matrix – Stakeholder opinion on the three hipothesis

Typologies of stakeholder	Hypothesis		
	1	2	2
A1– Producer	very good	good	poor
A2 – Cooperatives	very good	excellent	very poor
A3 – Commercial operators	good	excellent	poor
A4 – Processing industry	very good	medium	very poor
A5 – Agricultural unions	good	good	poor
A6 – Public institution	good	medium	poor
A7 – Scientific group	good	excellent	medium
A8 – Tertiary sectors	very good	medium	poor

Source: own observation, data collected direct survey

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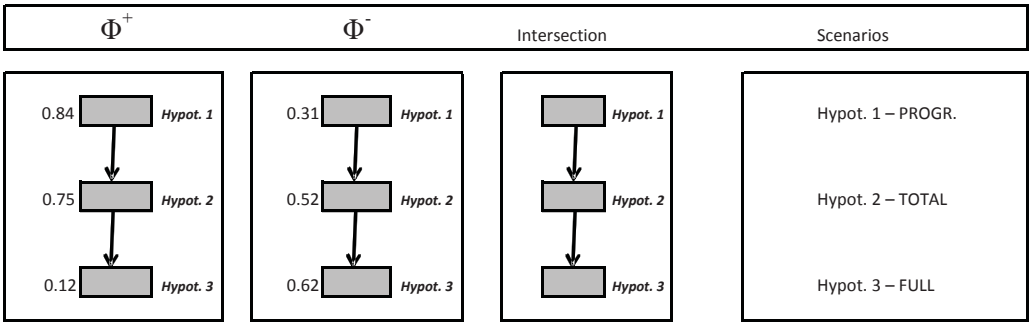

Figure 2. Possible alliance or conflict among the opinions of stakeholders

Source: own observation, data collected direct survey

from very poor, poor, medium, good, very good, and excellent (Table 2).

These results show that a big number of the stakeholder and operator groups selected agreed with the evaluation of the three hypotheses.

The results of the multi-criteria analysis, that is the evaluation of the three intervention hypotheses, highlighted that the hypothesis 1 "cohabitation with the *Citrus Tristeza virus*" is the predominant hypothesis, followed at short distance by the hypothesis 2 "total eradication and re-implantation", while the hypothesis 3 "abandonment or extirpation" gained only a marginal support (Figure 2).

The results obtained through the equity analysis were used to examine the possible alliances or conflicts among the opinions of the stakeholders about the decision of what hypotheses to adopt. Results of Table 3 show the value relative to the classification of the scenarios corresponding to the higher consensus level. These results show that a high number of stakeholders, besides agreeing on the classification of the different hypotheses to apply, were in agreement with the hypothesis 1.

Table 3. Classification of the scenarios corresponding to the level of consensus

Stakeholder List	Hypotheses		
	1	2	3
A1	0.78	0.83	0.21
A2	0.72	0.59	0.12
A3	0.85	0.65	0.38
A4	0.74	0.38	0.11
A5	0.84	0.52	0.23
A6	0.66	0.79	0.68
A7	0.57	0.92	0.82
A8	0.49	0.85	0.24

Source: own observation, data collected direct survey

Analysing data per the evaluation criteria variable values were reported from 0 (minimum) to 1 (maximum) in relation to the answers obtained by

Table 4. Medium levels of consensus and the relative scenario priority in relation to different hypotheses

Criteria of evaluation	Hypotheses		
	1	2	3
Biotic	*0.67*	*0.64*	*0.40*
Soil	0.73	0.81	0.21
Suitability	0.84	0.72	0.36
Altimetry	0.61	0.67	0.78
Water	0.59	0.43	0.32
Climate	0.58	0.57	0.31
Social	*0.71*	*0.59*	*0.34*
Employees	0.74	0.45	0.21
Specialization of labor	0.57	0.85	0.34
Ratio population/ imployees citrus	0.94	0.63	0.57
Degrees of work activity	0.58	0.42	0.23
Economics	*0.68*	*0.79*	*0.22*
Production	0.74	0.89	0.11
Price	0.72	0.92	0.13
Gross sellable production (GSP)	0.57	0.85	0.13
Production costs	0.71	0.85	0.15
Unit production costs	0.52	0.85	0.13
Gross income	0.68	0.87	0.17
Reduce of productivity with *Citrus Tristeza virus (CTV)*	0.85	0.13	0.12
Economic public contribution for CTV	0.68	0.97	0.81
Phytosanitary	*0.77*	*0.75*	*0.45*
The presence of CTV	0.89	0.52	0.92
Dissemination risk of CTV	0.52	0.85	0.21
Monitoring actions	0.93	0.67	0.54
Spread of other diseases	0.72	0.97	0.12

Source: own observation, data collected direct survey

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the different subjects interviewed (Table 4). On the whole, the values were more positive for the hypotheses 1 and 2, although different in relation to the different parameters considered. Specifically, for the biotic aspects, the matrix indicators report higher values for the hypothesis 2, in relation to the technical-growing aspects deriving from the eradication and re-implantation. As far as the social aspects are concerned, the evaluation reports higher values for the hypothesis 1, highlighting that in the terms of sector's operators and levels of activity, the hypothesis 1 shows higher values, which confirms that the cohabitation with the disease causes a lower social impact. Stepping into the analysis of the economic aspects, the hypothesis 2 is clearly superior for the competitive advantage that it offers in terms of the process innovation and product innovations. Finally, the phytosanitary aspects report of similar positive values for the hypotheses 1 and 2, in relation to the current endemic situation of the disease.

The efficiency of this kind of approach relies on the possibility of establishing a "learning platform" that eases the participation, information exchange and reciprocal comprehension of participants, who stimulate each other towards a sharing of the territory. The results allowed including several perspectives of the evaluation problem under study, as demonstrated by the different groups involved, increasing the perception of the planners about the acceptability of the alternatives proposed that may lead to improving the strategic decisions and then creating innovative ideas and new planning solutions, based on the possibilities offered by the participated processes.

On the whole, the results obtained from the combination of a participative tool and a multi-criteria analysis become strategic and can be applied to different scenarios at the international level.

DISCUSSION

According to the results obtained, it was possible to assert that the first hypothesis of the cohabitation with the Citrus Tristeza Virus was the one that presented the highest sustainability.

However, this research study is completed with the economic evaluation of the hypothesis 1 and 2, respectively, defined as the "differentiated model with progressive steps" and "eradication model of all surfaces".

The basic assumption of the model proposed in the hypothesis 1 is that a citrus fruits plant affected by the Citrus Tristeza Virus keeps living with differentiated productive results, based on the degree of affection, the virus variant and the cultivation techniques applied.

The second assumption is that the farmer counts on the profits derived from the citrus fruits yard as the only income source. Missing the GSP, the farmer is without any subsistence source.

The third assumption is that also with the support measures for this sector, at present the institutions, research and nurseries above all, cannot provide thorough answers to the needs of all citrus fruits farms.

Based on what was stated so far, simulations were performed, evaluating the economic implications derived from it. The case study considered a citrus fruits farm with the following characteristics: 10-hectares of extension, orange growing, 20-year-old implantation, sour-orange rootstock, early-phase virus spreading, 400 plant/hectare density.

The results were based on the farm on its whole (10 hectares) and analysing its level of activity (farm hours), production (farm production in tons), price per ton in euro, Gross Sellable Production (GSP), rewards deriving from the demand (considered con-

Table 5. Economic scenario for the citrus farm of 10 hectares – the "hypothesis 1 – Progressive replanting"

Indicators	Units of measure	Farm (ha)	1 year	2 year	3 year	4 year	5 year
		10	progressive replanting 25%				total replanting
Activity levels	hours/farm	2 520.00	2 394.00	2 268.00	2 142.00	2 016.00	2 268.00
Productions	tons/ha	216.00	162.00	108.00	75.60	129.60	172.80
GSP	euro/farm	38 880.00	32 400.00	21 600.00	17 388.00	32 400.00	43 200.00
GSP + EU bonus	euro/farm	45 380.00	38 900.00	28 100.00	23 888.00	38 900.00	49 700.00
Variable costs	euro/farm	37 163.20	33 446.88	26 757.50	26 014.24	31 588.72	33 446.88
Gross income	euro/farm	1 716.80	–1 046.88	–5 157.50	–8 626.24	811.28	9 753.12
Gross income + EU bonus	euro/farm	8 216.80	5 453.12	1 342.50	–2 126.24	7 311.28	16 253.12

Source: own observation, data collected direct survey

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Table 6. Economic scenario for the citrus farm of 10 hectares – the "hypothesis 2 – total replanting"

Indicators	Units of measure	Farm (ha)	1 year	2 year	3 year	4 year	5 year
		10	replanting 100%	new production plant			
Activity levels	hours/farm	2 520.00	1 260.00	1 512.00	1 764.00	1 890.00	2 142.00
Productions	tons/farm	216.00	–	–	64.80	108.00	205.20
GSP	euro/farm	38 880.00	–	–	16 200.00	27 000.00	51 300.00
GSP + EU bonus	euro/farm	45 380.00	6 500.00	6 500.00	22 700.00	33 500.00	57 800.00
Variable costs	euro/farm	37 163.20	18 581.60	22 297.92	26 014.24	29 730.56	33 446.88
Gross income	euro/farm	1 716.80	–18 581.60	–22 297.92	–9 814.24	–2 730.56	17 853.12
Gross income + EU bonus	euro/farm	8 216.80	–12 081.60	–15 797.92	–3 314.24	3 769.44	24 353.12

Source: own observation, data collected direct survey

stant even if undergoing a small digression during the 2014–2020 period of time), GSP with awards, the variable farm costs from which the gross income was calculated with and without farm's awards. For both hypotheses, there was considered a reduction of the levels of activity of the farm, in relation to the technical innovations besides the higher selling price compared to the higher quality of the productions deriving from the new implantations.

As shown by the following tables (Tables 5 and 6) and figures (Figures 3 and 4), the results from the two hypotheses reveal a sustainable scenario for the farm that adopts the hypothesis 1, that is, the differentiated model with progressive steps.

The economical results obtained with the adoption of the hypothesis 1, for the different indicators considered, report of more steady results in the long run.

Specifically, the level of activity, which is fundamental to justify the work of the farmer within the farm, revealed constant values along the gradual re-implantation period with the "hypothesis 1", while with the "hypothesis 2", that is, the total eradication, there was observed a collapse of the level of activity in the first year, then a return and normalization at the fifth year.

As far as the gross income with awards is concerned, it was observed that the farm under study, by adopting the "hypothesis1" showed values that were always positive, except during the third year when the results were negative. This condition, however, on the whole, allowed maintaining the management costs of the citrus fruits yard until the total re-conversion.

Stepping into the analysis of the "hypothesis 2", we observed for the gross income and the gross income plus awards negative values at first, second and third year; lightly positive results at the fourth year; while at the fifth year, the results observed were higher than those of the "hypothesis1".

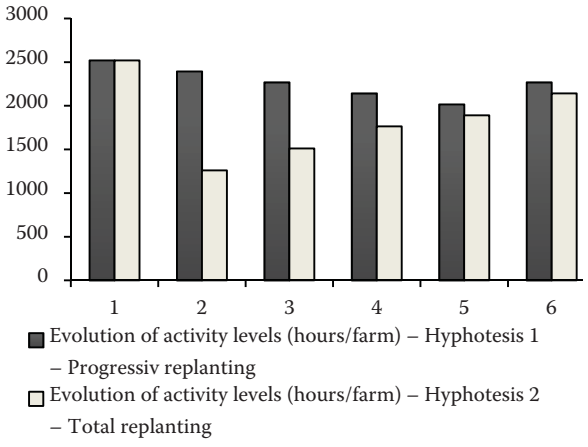

Figure 3. Evolution of activity levels in the citrus farm with the hypothesis 1–2

Source: own observation, data collected direct survey

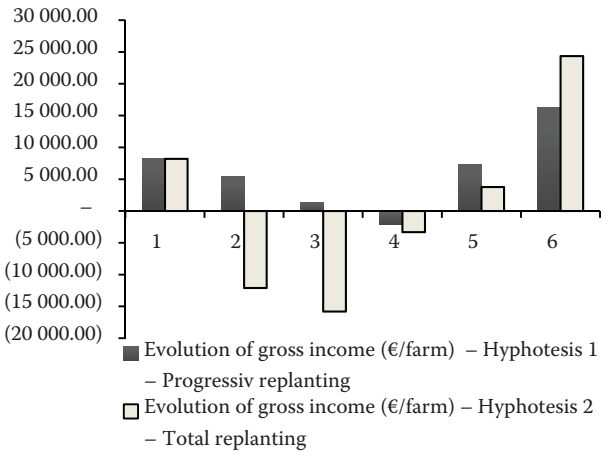

Figure 4. Evolution of Gross income in citrus farm with hypothesis 1–2

Source: own observation, data collected direct survey

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CONCLUSION

The analysis developed so far, simulating the adoption of the two intervention models (hypothesis 1 and 2), pointed out that the economic sustainability depends on many variables, among which the farmer who runs the farm plays a strategic role. The optimal application of the "hypothesis 1", the "differentiated model with progressive steps", is advisable for the farmer first, for the worker second, and in general, for those who work in the farm directly and whose income derives from the very citrus fruits productions, while the "hypothesis 2" of the total eradication may be preferred by the enterprises, even if from the social point of view the hypothesis 1 is clearly more sustainable also for these categories.

Stepping into the evaluation of the financial sustainability, of the possible measures supporting the citrus fruits farms affected by the Citrus Tristeza Virus, it is clear that the economic impact deriving from the hypothesis 1 is obviously more sustainable, since it allows the distribution of resources among the different economic periods, with the control and support for the farmer towards the re-conversion.

Regarding this, to perform the "differentiated model with progressive steps, a proposal for a specific measure of agricultural policy may be hypothesized, to be activated with a grant that provides for a decree of the long-time concession, allowing the management of the disease within four years upon the application.

This research allowed pointing out that the methodological approach adopted, based on the integration between the participated planning technique and the multi-criteria analysis, in the case of problems linked to the phytosanitary emergencies, represents a strategic tool. In fact, it allowed individualizing possible alternative scenarios and shared solutions in relation to the "complexity" of the subject that is characterized by the biotic, social, economic and phytosanitary implications. The specific operative implications, evaluated in this work, deriving from the application of the different hypotheses, showed that an ex-ante evaluation allows proposing of a sustainable model to the system avoiding the intervention strategies that do not fit to the sector dealt here. The efficiency of such a model of evaluation relies on the possibility of establishing a learning platform that facilitates the participation, information exchange and reciprocal comprehension of the participants that support a strategy for the development of the territory.

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