Review Article

Is Implementation of an Environmental Management System a Reliable Option for the Control of Plant Quarantine Organisms?

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Abstract - Plant quarantine organisms have emerged as an important issue that not only posesa significant threat to crops but as an issue that affects the environment and society as a whole. From this point of view, a management approach that will focus on the preparation, the preparedness, and the ability of interested parties and the society, in general, to secure against the entrance of a quarantine organism or react fast and implement appropriate measures to eradicate the quarantine organism if entered in a new area, is required. As a number of measures must be continuously implemented by many people, including public administration, environmental management systems that can adapt according to specific circumstances are proposed as a powerful tool for the control of plant quarantine organisms.

Keywords - Biosecurity, Environmental Management Systems, Eradication, Plant Quarantine Organisms, Transport.

I. INTRODUCTION

Quarantine organisms are now emerging as a very important issue both for the primary sector and the natural environment in general and, therefore, society. In fact is getting worse as it doesn't attract enough attention from farmers, public administration, even the scientific community that focuses on issues where experimentation is guaranteed and will probably lead to successful and straightforward results and conclusions.

Invasive organisms are considered native or alien species that spread with and without the aid of humans in natural or semi-natural habitats, producing a significant change in composition, structure, or ecosystem processes or causing severe economic losses to human activities (Copp et al., 2005). This is different from what pests and diseases are considered as these are defined as any species, strain, or biotype of plant, animal, or pathogenic agent injurious to plants or plant products (FAO, 2017).

Quarantine pests and pathogens are invisible. Further, the symptoms they cause are similar to those caused by other ordinary organisms,thus confusing the detection of the causal factors. In the case of quarantine plants, these are visible only after they enter and settle in an area, which again then is very late. In this case, the original infection is almost impossible to detect and prevent entrance and expansion into a new area. Normally quarantine organisms are not given much attention as people are usually not proactive but reactive, and they prefer to approach an issue after this is visible or start causing the financial cost or identify threats or adverse impacts to crops. Thus, preventative measures are not implemented, not even planned. Consequently, these organisms attract attention when the problem becomes visible, but then it is difficult to manage with because it has been installed, expanded, and much more resources in terms of monetary cost, time, experts, the devotion of public administration is then required to deal with than it would have been for the preventative actions.

Scientific literature is full of references on quarantine species that impose a threat to the environment and society, but with only a few cases of successful control and eradication after being introduced in a new area. Such a successful case is the bacteria *Erwiniaamylovora*, which was eradicated after being introduced in the Republic of Ireland (EPPO, 2016). Probably the island status of the Republic of Ireland supported the eradication efforts by stopping any further inoculation from distant infected areas.

II. REQUIREMENTS FOR A SUCCESSFUL QUARANTINE

Establishing quarantine is a much more complicated issue than the control of a conventional pest or disease of a crop. Similar to quarantining organisms that affect livestock or humans, the fast reaction in such an incident is vital. Proper and deep knowledge will help to design and implement countermeasures focused not only on the quarantine organism but also to secure healthy plants or animals trapped in the quarantine zone at the time of the incident. Usually, governments respond with the formation of quarantine when a dangerous organism enters a new area, hoping that scientists as well public administration are prepared to propose measures and strategies already tested to deal with this new situation and optimize exceptionally difficult decisions. These plans must have provisions not only for diseased plants or animals but, as it is stated earlier, for the healthy plants that happened to be found in the quarantine area, and some of them are usually subject to trade (Easton et al., 2015). As always, the implementation of quarantine creates a cost that will finally be paid by society. This cost must be reasonable and affordable, always having in mind that quarantine is a situation complex and will definitely require a considerable budget.

Quarantine is much more than the prohibition of transport of plant material with which people very often are not aware or familiar. Thus, clarified and easy-toimplement guidelines for the society are needed, specifically if it is to be implemented and observed by the public administration and public employees. If proper guidance is not provided, it will probably collapse as it will be the society itself that will not obey the designed measures.

Management plans, when they exist, appear to be highly valuable and effective for the prevention of entrance or during the eradication process of quarantine organisms. But as this is not the rule and no immediate measures and procedures are in place to deal with quarantine organisms, a framework of indirect measures should be designed and implemented to prevent the expansion of quarantine organizations when entering into the new areas. This falls in the context of an International Standard. According to ISO (2020), an International Standard provides rules, guidelines, or characteristics for activities or further results aimed at achieving the optimum degree of order in a given context. It can take many forms. Apart from product standards, other examples include test methods, codes of practice, guidelines, standards, and management systems standards.

There are two factors that dramatically affect the issue of quarantine organisms: (a) climate change and (b) facilitating the movement and transport of people and goods in terms of globalization and international trade (CBD, 2003). Regarding climate change, the most critical factor is the increase in the environmental temperature. In our days, with temperatures rising even less than 1 °C, they have become favorable for those organisms areas previously not suitable for settlement and development. A characteristic case is an alien species *Ailanthus altissima*, which originates in the warm and humid regions of Southeast Asia that, due to climate change, expanded rapidly and now is found everywhere except in the high altitudes and the poles.

Similarly, the facilitation of people movements (in our days there is a huge stream of human flows either using formal routes through immigration or informal and out of any control refugee routes) in combination with the transport of goods by removing administrative barriers and aided by the advanced technology such as trucks and airplanes with conservation chambers for fruits and vegetables, enable and facilitate the transfer of these organisms. A striking example is the bacterium *Xylellafastidiosa* that is found to infect olive orchards in the Apulia region in Italy. This was recently transferred from the American continent, where it is endemic, to Europe,

probably with infected tobacco plants. Both *Ailanthus altissima* and *Xylellafastidiosa* were successfully established despite the strict control measures implemented afterward.

It has to be noted that plant health differs from food safety and animal health in the biosecurity sphere. There is not an agreement on organisms recognized as harmful to plants in contrast to harmful food-borne microorganisms or animal pathogens. Instead, each territory has or should have its own list of regulated pests that are the only plant pests may be regulated by Sanitary that and PhytosanitaryMeasures, which in turn form the basis to regulate imports of goods in international trade and must be based on international standards or be justified by "scientific evidence" and risk assessment (Black and Bartlett, 2020). Specifically for the EU, quarantine organisms are plant pathogens that are not yet present or are present but not widely distributed and are deemed by EU legislation as being harmful to plant health. The policy is aimed at preventing the introduction and further spread of such organisms. Since the import and use of such organisms are in principle prohibited, each EU member is obliged to supervise compliance with the import ban and, in cases where approval is given, to supervise their contained use in a manner that is safe for plant health. The main principle underlying this list concerns the protection of plant health (Bureau Biosecurity, 2020). In line with this, the EU Council issued the Council Directive 2000/29/EC of 8 May 2000 on protective measures against the introduction into the Community of organisms harmful to plants or plant products and against their spread within the Community (European Union, 2000).

What can distinguish between pests and invasive organisms is that pests are introduced into a new territory unintentionally, whereas invasive quarantine plants are usually introduced by deliberate human actions. In both cases, human activities, either unintentional or deliberate, appear to be the most significant factors for the introduction and expansion of organisms, both conventional or quarantine. From this point of view, in order to deal with quarantine organisms, laws, regulations, and directives are issued at both national and supranational levels, since only if they are implemented on a large scale and by many interested parties can they be proved effective.

III. PROVISIONS OF AN ENVIRONMENTAL MANAGEMENT PLAN

Quarantine is more a matter of management and less a matter of plant protection. Given that it is also an environmental issue, we conclude that this issue of quarantine organisms is primarily a matter of environmental management in a broad sense. What complicates the case is that this is shifted from the technical issue that must be addressed by a scientific perspective to a political issue with legislative aspects that influence implementation and efficacy, and this must always be taken into account when decided and designed.

The scope of an Environmental Management System and all parameters affecting the ability to achieve the intended results required for an organization that interacts with the environment must be properly defined. Such parameters are the human resources and equipment (Wang et al., 2002) necessary to support the system. Necessary is also any information concerning quarantine organisms near or in the area of interest as this will make the organization informed about any treats in its vicinity. In this way, the organization will be able to design the methods and strategies it will have to implement to achieve the aims set in the environmental management system. Such an approach was implemented to control witchweed after it was discovered in South Carolina. Very efficiently, efforts were not restricted to technical issues such as locating of infestations, biology issues, prevention of seed production but also invested in public awareness, as with the magnitude of the control program, the difficulty of identifying infected sites, and the weed's potential for spread it had been essential to involve agricultural agencies, commodities groups, agriculture-related organizations, and the general public in various aspects of the program. The State Extension Services of the U.S were mobilized, newspapers and magazines were used, questionnaires and brochures were mailed. The public was informed about the seriousness of the problem, how to identify the plant and report inspected finds, regulatory procedures, and assist in the eradication. This effort has generated much public support for the implementation of the program (Eplee, 1992) and showed that effective quarantine of such a pest to within or more geographic units is a viable possibility (Withrow et al., 2015).

Each organization should identify the external environment and the parties it interacts within performing its activities, who its suppliers are (suppliers must be informed about the commitment and efforts made by the organization to deal with quarantine organisms which must be the first level of defense against the entrance of a quarantine organism) and what risks undertake within their interference with society in case its activities may facilitate the transport of quarantine organisms. Import activities, especially from areas not well supervised, with inefficient public administration must be considered as risk activities. Understanding the risks the organization may face as a result of this interaction will help to develop a credible strategy overtime to either avoid it or maximize the effectiveness of control methods it will employ. The organization should also be aware of the needs, expectations, and requirements of their clients and avoid complications in between businesses. This will help to plan its actions in a timely manner and reduce the risk correspondingly, which may allow quarantine organisms to enter into a new area. A failed case is the entrance of palm weevil (Rhynchophorusferrugineus, Olivier) in Greece, which accompanied the import of palm trees in Crete in 2005. This weevil rapidly expanded in the rest of Greece, attacking any palm tree.

Along with suppliers and taking into account their expectations in between with the organization business

affairs, the organization should identify its departments, their functions, services, and products they produce and which may have an interaction with quarantine organisms, either because products are vulnerable to quarantine organisms or because products or trade networks can be used to spread the quarantine organisms. This may include the technical department or any transport means that may facilitate the transport of a quarantine organism. Material such as crates must always be checked as it can be the means for organism transport. This information can also help identify critical points associated with quarantine organisms and thus design an effective environmental management plan. For example. *Mimosa pigra*(giant sensitive tree) was introduced to Australia at the Darwin Botanic Gardens in 1891. The first major infestation was reported in 1952. The seed was transmitted in the sand, but it was the extraction of sand from rivers for building purposes that helped this species spread. After identifying that, Australia set a national control strategy to control the transport of building sand, paying special attention to tires and wheels that are considered as significant pathways for the species spread (CRC Weed Management, 2003).

The environmental management system must start with the environmental policy adopted by the organization, which should refer to quarantine organisms, as well as to the environmental impacts that occur from the entrance of these organisms in a referred area. In fact, quarantine organisms must be at the core of the environmental policy, which set the framework for aims and targets of the quality system and document the organization's commitment to approach this issue as credibly as possible and improve the performance of the environmental management system in terms of quarantine efficacy in the light of technological improvements. This particular reference of the policy must be highlighted to the entire personnel of the organization as this will maximize the effectiveness of the system.

The assignment of a person who will play the leading role in the operation of the organization, as well as ensuring compliance with environmental rules and procedures to eliminate the risk of the quarantine organism being transferred from and to the aforementioned organization, is of imperative importance. This person will ensure that a suitable environmental policy has been set up and the objectives for the control of quarantine organisms have been set. The objectives are integrated into the organization's operational procedures that will evaluate the environmental performance of the organization and will finally report the degree of conformity against the aims and targets set. This person must be well qualified, educated and trained and with good communication skills.

The allocation of competencies and responsibilities for each employee in the organization is very important if it is to halt quarantine organisms. Qualified persons for this role will maximize the effectiveness of all actions of the system. These responsibilities must be well explained to personnel in order for employees will know to whom they have to refer in case of a crisis.

As mentioned, quarantine diseases are invisible and what is perceived is the symptoms in the crops (such as the symptoms that appear on the leaves) or in the case of quarantine weeds. It is the plants themselves that will be identified after being transported to a new place. As in conventional plant pests and pathogens, management of quarantine species relies on timely detections to minimize the effects of initially undetected entrance and having in mind that the detection may be imperfect, especially at the early stages of the entrance (Marshall et al., 2009). To strengthen the detection process, risk analysis may be performed. Risk analysis can alleviate, at least partially, the uncertainty on quarantine organisms detection (Bartell and Nair, 2003; Burgman et al., 1999; Caley et al., 2006). Risk assessment can also reduce the cost for the preventative efforts and help the early detection of a quarantine species as it may focus on crucial areas or in aspects of the environmental management system such as the training level of the employees.

The shape of a quarantine zone appears to be significant for the detection and eradication of a quarantine organism. Quarantine implemented along and around established zones and dispersal pathways have been recognized as effective tools that help to address the typical lack of knowledge about new invades and the common inability to detect them in a limited manner (Hennessey, 2004).

The environmental management system must be developed in such a way that plants or other material likely to be contaminated by quarantine species will be detected. Other issues not directly related to crops must be tackled. These may refer to the external environment, such as loosening of quarantine measures in neighboring areas that actually may increase the level of alert. It is of imperative importance that the design should be flexible through the review process to adapt to changes in the external environment, especially when emergencies or new infestations occur. This is a credible ex-ante effort aimed at preventing or controlling the organisms at their early stages of development rather than suppressing them and thus will save valuable resources in terms of money and time.

Continuous improvement through the implementation of a firm training program instead of complacency is necessary for a credible environmental performance. This will help all actors increase the level of efficacy. The improvement relates both to personnel competencies and also to any means such as technology equipment, improved audit, and review of the management system.

Planning should include provisions on both compliances with regulations and directives and actions to be taken to address relevant threats or take advantage of opportunities to mitigate adverse effects of quarantine organisms or improve the overall management system. Such an opportunity is the development of a novel risk analysis method or the development of a new technology relating to the early detection of the entrance of a quarantine species. This will, in addition, reduce the overall costs required.

As part of the planning process, the organization must establish aims and targets that should concern all levels of its operation. These objectives should be consistent with general environmental policy, measurable and feasible, monitored, communicated to all employees responsible and third parties, and kept up to date, confirming a firm approach in the operation of the organization which is definitely perceived and therefore will exhibit trust to third parties.

Since the observation of quarantine must be continuous and consistent, the organization should determine the actions to be taken, the human and financial resources to be allocated, the persons responsible for implementing the measures and for observing and monitoring their implementation as well as for evaluation of their effectiveness, including the level of awareness and responsiveness of all involved.

It is now confirmed that actors at the management level are influenced by those at the policy and the lifestyle level. Still, policies aiming to prevent and control biological invasions will not reach implementation if this is not of interest to the related actors at the management level. Stakeholders impaired by biological invasions may push to promote nature conservation or to implement invasive species control. Finally, it is not that certain that all stakeholders will have a mutual understanding to participate in the control strategies and maybe not be willing to contribute if they do not have an interest in this (Rodriguez-Labajos et al., 2009).

Adverse effects that can happen on both the natural and the economic environment after the introduction of an invasive species must be thoroughly communicated. Society will become aware and willing to contribute to management efforts. Involvement of society is demanded as it will maximize the potential of management, either by avoiding practices that can facilitate transport or taking part in the eradication efforts by early reporting new infestations.

The issue of personnel competency is crucial. People involved in this process must be well educated and trained. Specifically, those dealing with plant material must have the skills and knowledge to be alert and able to detect any batches of plant material suspicious of carrying the infection and stop transport into a new area, as this will cause degradation or even destruction of the natural environment and crops and will dramatically reduce farmers' income. This expertise should be acquired through education, training and experience gained. Education and training programs should have at their main objective and priority the issue of quarantine at least as high as pesticide residues in plant products. It should be understood that it is the proper education and training of those employed in this field that is most effective in dealing with quarantine diseases as it enables trainees to recognize and prevent the problem from being created rather than trying to tackle and confront it it afterward. In fact, such an approach requires a much smaller budget than the budget required when a

quarantine organism is introduced in an area and actions to eradicate start with a delay, usually with low possibilities for a successful result. In the context of their training, all participants should be aware of revisions to instructions or regulations and adjust their efforts accordingly. As this is a matter of worldwide concern, mutual understanding by all actors is necessary, but conformity to the law is also required. Understanding the relevant regulations and directives as far as possible should be pursued as a goal in training and education programs.

The functioning of the organization must be structured and process-based as complementary activities are needed. Processes must be reviewed at regular intervals to incorporate changes in the internal and external environment of the organization. If some activities are outsourced and subcontracted, it should be ensured that these are well controlled by the top management and subcontractors are absolutely qualified for the task assigned. Given the importance of planning, environmental requirements for the supply of products and services should be included, and relevant environmental requirements against the external parties with which the organization interacts should be disclosed. These requirements should be up-to-date and documented so as not to be misinterpreted. This will secure compliance and effectiveness.

Activities and specifically trade activities must be well prepared and documented. It should be prepared to respond by already planned actions to prevent or minimize adverse environmental impacts. These actions fall into a range of activities as training of staff and conducting preparedness exercises, assessment of preparedness in other real emergency situations, develop actions (such as strict controls) to prevent or limit the effects of quarantine species taking into account the specific requirements of each organism, perform periodically readiness exercises to check the capability of its staff, review and update relevant procedures in the light of scientific developments as well as new regulations and guidelines issued, provide relevant information of quarantine organisms to suppliers and the staff working in its organization, improve competency of personnel, provide budget and time to public administration given that a major portion of this task will be assigned to governmental agencies, promote the cooperation between public administration and scientific community and stakeholders, avoid extra barriers in trade, develop risk assessment methods to review among the rest, distribution, biology and economic impact with the aid of computer software and highlight areas where climate would be more suitable and probable for the quarantine organisms establish (McLeod et al., 2002).

The organization will need to determine exactly what is measured and monitored. Such would be reports of the spread of quarantine diseases or of plant species that are infected or insect vectors of the pathogenic microorganism. The monitoring, analysis, and evaluation methods needed to achieve positive results should be defined. Critical stages for the measurements must also be specified. These can be determined depending on the time of year, the vegetative stage of the plants, or other factors. Timing of the analysis of the measurements should also be determined, which is crucial since the timely analysis can prevent the spread of quarantine diseases. The effectiveness of the management system, including the issue of quarantine, should be evaluated at regular intervals, and the review should take into account the level of staff training, preparedness for the crisis, etc.

Environmental performance and compliance with the requirements of standards, regulations, and directives should be monitored through established procedures to assess, among the rest, the degree of conformity against the objectives and the adequacy of the resources allocated. The results of the reviews should include all the information necessary to continue or adapt the quality system to new requirements in order to achieve the objectives.

The results of environmental performance audits, which may be positive or negative, contribute to the continuation of the management system and the adoption and implementation of necessary measures if the system requires adjustments. Top management should investigate the reasons for corrective actions. The end result of these actions must be the continuous improvement of the system to achieve the highest degree of efficiency in controlling quarantine organisms' expansion.

IV. CONCLUSION

We have entered into a new era. The era that quarantine organisms due to pharaonic changes, both in natural but also in the socio-economic environment worldwide, are forcing us to change the way we consider plant protection and agriculture in general. Every time such an organization enters and settles in an area, significant disorder happens. Environmental degradation, crop losses, business failures, cost, and time waste prevail. Compared to the past, what has changed is that they attract attention from the interested parties, which is helped by the Mass and Social Media that inform people in real-time about the consequences they cause in crops and the society in general.

Quarantine organisms call for more stringent requisites for producers and exporters with the implementation of sanitary, phytosanitary and quality-related regulations and standards reshaping the total agri-food sector worldwide (Henson and Humphrey, 2010). On the other hand, it appears that stringent methods implemented have a negative and substantial effect on imported plant and food volumes, and the reduction is higher if stringency increases in developed countries. Negative effects are not uniform in trade but depend on trade aspects influenced (Melo et al., 2013).

There are no uniform and consistent methods to implement, either because each quarantine organism is a unique case, but also there is not a common approach on this issue worldwide. Given that, instead of uniform measures, it is uniform processes with affordable cost, easy to implement that must be adopted and developed. Improved technology with the aid of IT technology is another means with high potential for quarantine management. Monitoring of plant temperature or chlorophyll fluorescence, especially when crops canopy is scanned by a drone with an incorporated thermal camera, maybe prove an effective technique to identify infestation if crops or forests have been attacked by quarantine organisms and, more important at the very early stages of infections when eradication is still feasible.

More flexibility in management in terms of continuous improvements, continuous training, adaptation to changes in the environment, the performance of administration, proactive instead of reactive actions, proper monitoring schemes is considered as the only feasible, documented, and audited strategy in order to fill in the gap of non complementary measures between authorities, which gap, is finally exploited by quarantine organisms to enter into a new area.

Quality systems offer the advantage of flexible management instead of a strict approach to control quarantine species. This will overcome the fact that while invasive species are universally recognized as a threat to the environment, there is a perspective in which not all nonnative species pose a threat to biodiversity, specifically when environmental conditions change, where plants more suitable to ambient conditions are likely to alter and shift to "invasive" status, with consequential effects on plant communities (Black and Barlett, 2020).

The quarantine process must be well quantified in terms of monetary cost, society annoyance, trade disturbance, and cost-benefit analysis for the environment and society in order for responsible authorities to decide if it is worth investingin this and what will be the cost that finally will have to be paid by the society. Transparency and repeatability are important elements of the process, which will result to set the confidence of the society, which in turn will feel the owner of the whole process and will positively participate in this (Sansford, 2002; Soliman, 2015).

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