Miguel António Taveira Franco Sousa Arruda

"Ambiente, Saúde e Segurança"

Management of agricultural waste on a sample of farms on the island of São Miguel (Açores)

Gestão de resíduos agrícolas numa amostra de explorações da Ilha de São Miguel (Açores)

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DEPARTAMENTO DE BIOLOGIA

Ponta Delgada

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Relatório de Estágio para a obtenção do Grau de Mestre em Ambiente, Saúde e Segurança.

Trabalho efectuado sob a orientação de:

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Mestre Sara Santos Silva

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Dedicatória

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Abstract

Millions of tons of solid wastes are generated from agricultural, municipal and industrial sources every year. These amounts are expected to increase exponentially due to the growth of the world's population and the increase of urbanized areas. Agriculture represents the main pillar of the economy of the Autonomous region of the Azores, contributing decisively to the equilibrium of the trade balance. The agricultural sector currently represents approximately 50% of the Azores economy. In this context, the Municipalities in the largest island, São Miguel, were interested in understanding what is the final destination generally given by farmers to particular types of agricultural waste: plastic, packages of phytosanitary and veterinary products, used tires and used lubricant oils. The instrument used for data collection was a questionnaire. To that end, a table with research questions was built. This study concluded that the legal knowledge of the majority of farmers regarding waste was reduced. This might be related to the lack of effective training and information campaigns. Even so, farmers showed concern about the environmental impact of waste produced in their activity though most are unaware of the correct final destination that should be given to waste. Although farmers stated that they consider important to dispose of the waste properly, they were not sure about their responsibility in the process. It is concluded that a considerable portion of the targeted waste types in this research does not have the adequate final destination. In order to reverse this situation, training and awareness campaigns directed to farmers should be implemented.

Resumo

Milhões de toneladas de resíduos sólidos urbanos são gerados a partir de fontes agrícolas, urbanas e industriais, a cada ano. Esses valores devem aumentar exponencialmente devido ao crescimento da população mundial e ao aumento das áreas urbanizadas. A agricultura representa o principal pilar da economia da região autónoma dos Açores, contribuindo decisivamente para o equilíbrio da balança comercial. O setor agrícola representa atualmente cerca de 50% da economia dos Açores. Neste contexto, a os municípios da Ilha de São Miguel, a maior do arquipélago, pretendia perceber qual o destino final geralmente dado pelos agricultores a resíduos agrícola específicos: plásticos, embalagens de produtos fitossanitários e veterinários, pneus usados e óleos usados. O instrumento utilizado para a coleta de dados foi um questionário. Para o efeito, foi construída uma tabela com questões de investigação. Este estudo concluiu que o conhecimento legal da maioria dos agricultores acerca dos resíduos era reduzido. Isto pode dever-se à falta de planos de formação e de campanhas de informação eficazes. Ainda assim, os agricultores mostraram preocupação em relação ao impacte ambiental dos resíduos produzidos na sua atividade, embora a maior parte não tenha conhecimento do destino final correto a dar aos resíduos. Embora os agricultores tenham referido que consideram muito importante tratar os resíduos de forma adequada, não tinham a certeza de qual a sua responsabilidade no processo. Concluiu-se que, uma parte considerável dos tipos de resíduos-alvo nesta investigação, não têm o destino final adequado. Para reverter essa situação devem ser implementadas campanhas de formação e sensibilização dirigidas aos agricultores.

Introduction

Solid waste management (SWM) has become an issue of increasing global concern as urban populations continue to rise and consumption patterns change. The health and environmental implications associated with SWM are mounting in urgency, particularly in the context of developing countries. While systems analyses largely targeting well-defined, engineered systems have been used to help SWM agencies in industrialized countries since the 1960, collection and removal dominate the SWM sector in developing countries (Marshall, 2013).

Millions of tons of solid wastes are generated from agricultural, municipal and industrial sources every year. These amounts are expected to increase exponentially due to the growth of the world's population and the increase of urbanized areas (EPA, 2006; 2011). In 2008, the EU-27 generated more than 2.6 billion tons of waste, of which 98 million tons, or 1.7 %, were from agriculture, forestry and fishing (Eurostat, 2011).

Improved waste management is an essential element in efforts to make Europe more resource efficient. If a country is to generate greater economic returns at lower costs to the environment then it must find ways to extract more value from the resources that it takes from nature, while cutting the burden of emissions and waste. One key means of achieving that is by shifting waste management up the waste hierarchy — reducing waste disposal (for example landfilling) and instead focusing on waste prevention, reuse, recycling and recovery (EEA, 2013).

In recent years these important goals have been intergraded into European environmental policy, notably the European Commission's Roadmap's on a resource efficient Europe (EC, 2011) and the EU's Waste Framework Directive (Szilágyi, 2012). But national efforts to shift up the waste hierarchy have been under way for longer, in

large part driven by earlier EU legislation such as the Landfill Directive (EPD, 2002). Together, these instruments establish a range of waste management targets and broader goals for the years to 2020.

In Portugal, the urban waste sector is regulated by various legislative documents, which can be divided according to their scope, respectively into management and sector-specific legislation. The characterization of the management legal framework can start with Decree-Law No. 239/97 of September 9. Few years later, this diploma was altered by the Decree-Law No. 178/2006 of September 5, which set the waste management regime, transposing into national law the EU Directives (Marques & Simões, 2010). The waste management is one of the cornerstones on which to base a strategy for sustainable development in the Autonomous Region of the Azores, whereby, through the Regional Legislative Decree n.º 10/2008/A, May 12 approved the Strategic Plan for Waste Management of the Autonomous Region of the Azores - PEGRA. Later, the Regional Legislative Decree n.º 29/2011/A, November 16 established the general regime of prevention and waste management. With this objective, and given the dysfunctions that had been identified in previous legislation, a coordinated structure with all entities with an interest in the matter, prepared the operational plan contained in PEGRA. Therefore, a comprehensive legal framework for waste management was created, which promotes an approach according to the national and community obligations on this matter, establishing the frame lines that allow the operation of a set of techno-systems intended for the treatment, recovery or disposal of various types of waste.

With nine inhabited islands ranging from about 12 to 750 km^2 and with a total population estimated at 246,772 people, the Azores generates about 145,000 tons of

waste, largely concentrated in the islands of São Miguel (53%) and Terceira (29%) (SRAM, 2012). Several management options are being followed for urban waste, including composting of plant material, recycling of urban waste through the use of specific collectors, *"ecopontos"* (glass, plastic and metal, paper and cardboard), but also with the installation of waste separation stations (*"ecocentros"*) at each of the islands (IRA, 2012; SRAM,2011). Also, two incinerators are planned for Terceira and São Miguel islands.

Agriculture represents the main pillar of the economy of the autonomous region of the Azores, contributing decisively to the equilibrium of the trade balance. The agricultural sector currently represents approximately 50% of the Azorean economy, with milk production accounting for 73%. This sector still employs roughly half the working population. Furthermore, the yearly milk production in the Azores—approximately 80% of which is exported—represents roughly 27% of the total Portuguese production (Silva *et al.*, 2011). The area of utilized agricultural area of farms of those producers, who, in 2008/2009, were licensed, totalized 72,208.95 ha, being almost entirely occupied by crops intended for animal feed. In 2008, the producers of the reference had 93,197 cows (GPSRAF, 2011). This activity has originated environmental impacts including a considerable reduction in the extension of native vegetation (Silva, 2004), and has contributed to the eutrophication of many large and small lakes in different islands (Bio *et al.*, 2008). Even taking into account that currently only 31% of vascular plant species are native to the Azores and of these 24% are endemic (Silva *et al.*, 2009), the archipelago continues to present great environmental value, as part of the Macaronesian biogeographical region, which is one of the richest areas of biodiversity in Europe. Meanwhile, the Azores have been considered as one of the most sustainable destination

for nature tourism with several islands designed and Biosphere reserves (Silva, 2013), thus it is crucial to make farming activities compatible with other economic activities like tourism and with environmental management practices.

According to the Strategic Environmental Assessment of the Rural Development Programme of the Autonomous Region of the Azores (PRORURAL) 2007-2013 (AGRO.GES, 2007): The information on agricultural and forest residues is very scarce. Turned on its characterization preparatory version of the Strategic Waste Management Plan of the Azores (PEGRA), still under development report and therefore not published. This document defines agricultural residues such as those resulting from activities within the CAE 01, 02, 05, 15 e 55, with the exception of products suitable for use as fuel for energy production (agricultural biomass and forest biomass). Thus, this definition includes waste such disparate productions as debris, animal droppings, or waste plastics and packaging machinery. There are very few figures on the production of agricultural residues, making PEGRA only reference to a total of 4,304 tons / year. Another problem of the archipelago is the illegal dumping of waste, having been created in 2002 towards its decline, an Action Plan on Integrated Waste Management (PAGIR). Under the first phase of the program, a survey was made of the number of local waste disposal in inappropriate areas, and it was found a number of seven hundred sixty-one points of illegal dumping. The second phase was aimed at finding solutions to public and private to improve the environmental situation identified entities, as well as the prevention of future situations deposition in inappropriate places. According to the report, the rate of execution of this plan was around 54 %, having solved 409 cases of illegal disposal.

Moreover, with the entry into force of the General Administration of Waste Management, “the producers of waste should use the segregation of waste at source in order to promote their recovery by rows and flows”, which of course applies to agricultural waste. Thus, a farmer is in fact required under the provisions of the General Regulations of Waste Management, the triage of waste produced on their property, and who is responsible, and is taken as an offense punishable by fine with “breach of the duty to ensure waste management, whom provided the art. 5, fits this responsibility”, “not separation at source of waste produced, in order to promote its recovery referentially…”. It is very serious, punishable offense environmental pursuant to Law number 50/ 2006 of 29 August, amended by Law n. º 89/2009, of 31 August, and rectified by Statement of Rectification number 70/2009 of 1 October , the commission of the following acts: “They're also banned the abandonment of waste, incineration of waste at sea and its injection into the soil, open burning and dumping of waste at sites not licensed to carry waste treatment.”; “The mixing operation , including dilution of hazardous waste with other hazardous waste or with other waste, substances or materials is prohibited , except in cases duly authorized”; “It is prohibited to conduct waste treatment operations not licensed under this ordinance.”; “The activity waste treatment must be licensed for public health and environmental protection”; “The licensing authority may require the operator of waste management , a reasoned decision to take the action it deems appropriate to minimize or offset unanticipated negative effects to the environment or to public health arising during the operations of waste management”; “... The licensing authority may suspend or revoke the license issued by itself”; “The management of specific waste streams is subject to license or authorization pursuant to special legislation, applying the provisions of this ordinance to all that it is

not expected.” To very serious offenses correspond to the following fines : a) if committed by a natural person from € 20,000 to € 30,000 for negligence and € 30,000 to € 37,500 in the case of fraud ; b) If committed by legal persons, € 38,500 to € 70,000 for negligence and € 200,000 to € 2,500,000 in the case of fraud .

An offense serious environmental punishable under the same legislation, the commission of the following acts: The breach of duty to ensure waste management, “Principle of management responsibility”; “Responsibility for waste management, including the costs involved, it is the original waste producer, without prejudice to can be attributed, in whole or in part, the producer of the product which the waste came and shared by the distributors of such product if such a course of specific legislation. The production, collection and transportation of hazardous waste: “The production, collection and transportation of hazardous waste, as well as its storage and treatment are carried out under conditions that ensure the protection of the environment and health, watching assurance measures traceability from production to final destination” - Principle of protection of human health and the environment” - constitutes a priority objective of waste management policy to prevent and reduce risks to human health and the environment ensuring that the production, collection and transport, primary storage and treatment of waste are developed using processes or methods which are not likely to have adverse effects on the environment, including pollution of water, air, soil, allocation of flora or fauna , noise or odors or damage to any landmarks and landscape.” The serious offenses correspond to the following fines: a) if committed by a natural person from € 2000 to € 10,000 for negligence and € 6000 to € 20,000 in the case of fraud.

In this context, the Association of Municipalities of São Miguel (AMISM) was interested in understanding what is the final destination generally given by farmers to agricultural waste. In the Azores, there is occasional and unsystematic reporting of undue deposition of those residues in agricultural fields and the nearby waterlines.

This is in agreement with findings for other regions (Damalas *et al*., 2008; Al Zadjali *et al*., 2013), where a considerable proportion of farmers release residues over non-cropped areas, into irrigation canals and streams; dump the empty containers by the field or throw them near or into irrigation canals and streams; burn the empty containers in the open, or dispose of containers in general waste collectors. Thus is it of utmost importance to identify the final destination given to agricultural waste, as well as any factors that might be blocking farmers from using the most adequate practices for waste disposal.

Within this report, the term "agricultural waste" refers to waste from the farm and/or livestock or similar. Among the different types of residues, the present work regards the following: used tires, used oils, packaging from plant protection products, veterinary products packaging, and plastics non-hazardous. The final destination of those residues in the island is established by law and involves penalties for undue disposal (IRA, 2012).

The aim of this research was to establish the methods used by farmers to dispose of the types of waste mentioned above. A questionnaire was constructed and applied to collect information on how farmers presently manage solid waste on their farms.

Materials and Methods

Construction of the Questionnaire

The instrument used for data collection was a questionnaire. To that end, a table with research questions was built (Table 1). The questionnaire includes the following structure.

Characterization

A first part refers to the scope and subject of study, such as the confidentiality of responses and a second part regards the socio-demographic and professional characteristics of the farmers (gender, age, place of residence, academic level, professional training and work activities).

Farmer's attitudes towards the targeted residues

This part of the questionnaire includes nineteen Likert scale items in which the questions are divided into several subjects (see Table 1). This scale was responded according to four-point options, ranging from "Strongly disagree" to "Strongly agree".

1) What is the concern of farmers towards the environmental impact of the waste produced in their activity?

Even if legislation is available, and known, awareness about the possible negative environmental impacts derived from an economic activity might lead to more prompt compliance with regulations (Herzon, 2007).

Table 1. Items designed to ascertain final destination given by farmers to target residues in São Miguel Island, Azores.

Research questions	***Questionnaire items***
What is the concern of farmers towards the environmental impact of the waste produced in their activity?	- The waste produced in the agricultural activity may adversely affect the environment. - The waste generated in agriculture is not the most environmentally friendly. - Farmers are concerned with the fate they give waste generated in agriculture. - The destination for each residue is common knowledge among farmers.
Do farmers distinguish the different types of waste?	- The residues generated in agriculture are all of the same type. - Farmers do not know quite well where to deposit some waste. - There is waste that can be more harmful to the environment.
What is the legal knowledge of farmers about waste management?	- There is legislation covering the proper disposal of waste. - The law applicable to the farm waste is properly disclosed.
Which is the knowledge of farmers regarding the disposal of waste?	- There are proper procedures for the deposition of each type of waste. - Waste is disposed of according to its type. - Farmers know how waste is treated after collection by the competent authority.
Why farmers do not correctly dispose of waste?	- Sometimes we do not have time to dispose of the waste properly. - Is not very important to dispose of the waste properly so sometimes we do not. - The responsibility of directing the waste is not of the farmer, so sometimes he does not.
What is the willingness of farmers to change habits?	- Farmers can also participate in a more proper waste disposal. - Farmers are available to dispose of waste properly provided that they are informed. - Farmers are not available to improve waste treatment. - Farmers are available to dispose of waste properly provided that they are informed. - Farmers are not available to improve waste treatment.

2) Do farmers distinguish the different types of waste?

Different types of waste may have different environmental impacts and different collection pathways (Knussen, 2008), thus it is crucial to know if farmers are acquainted with this fact. This is the basic knowledge necessary to correctly dispose of waste.

3) What is the legal knowledge of farmers about waste management?

Although legislation exists regarding disposal of different types of waste, including hazardous waste, in some cases professional groups including farmers, might not get the pertinent information due to lack of legal training among other factors (Reis, 2013).

4) Which is the knowledge of farmers regarding the disposal of waste?

Even if farmers know the legal constraints associated with a correct management of waste, making waste management a reality involves practical, operational, and motivational issues (Reis, 2013).

5) Why farmers do not correctly dispose of waste?

Lack of training, resource or time, or reduced organizational abilities might impair farmers from proceeding correctly (Knussen, 2008). Thus, to suggest meaningful and effective ways of overcoming possible inefficiencies, an understanding or the underlying reasons is needed.

6) What is the willingness of farmers to change their waste disposal habits?

Motivational issues or operational limitations might prevent farmers from changing their behavior (Knussen, 2008).

Impact

Four open items were included about the amount and impact of the different types of waste produced in the farm. This is aimed to determine if farmers distinguished residues according to their amount and their possible environmental impact.

Final destination

Six items were used to ask the final destination given to the targeted waste types (used plastic packaging, plastic residues used on crop management and storage, pesticide containers, containers of veterinary products, used tires, and used mineral oils). Suggested final destinations included: burning in the open, burial in the ground, abandonment in the soil, abandonment in trails, abandonment in water lines, delivery to the environmental authorities, deposition at urban waste collection points, and other (which?).

Official programs for hazardous waste disposal

Five items were included asking about particular means of waste disposal already established in the Azores (*Valorpneu*, *Ecolub*, *Valorfito*, *Valormed*) (APA, 2011). *Valorpneu* main objective is to create and develop a system to manage and process adequately the flow of used tires generated annually, the collector entity in the Azores is Varela e Cª, Lda. In 2011, only in the Azores 1552 tons of used tires were collected.

Ecolub has the mission to fulfill the obligations in force in the management of used lubricating oils, facilitating compliance by companies and the economic actors involved, the collector entity in the Azores is Varela e Cª, Lda.. In 2011, only in the Azores 1,786.3 tons of mineral oils were collected (SRAM, 2012).

Valorfito, name by which the Integrated Management of Packaging Waste in Agriculture is known, aims to the periodic collection of packaging waste of phytosanitary products and their final management (APA, 2011).

Veterinarians are responsible for collecting and forwarding used packaging and other waste produced in clinical practice acts, in this sense they should contact the *Valormed*, the company responsible for the management of packaging waste and medicines out of

use that was created by distributors and pharmacies. The specificity of the drugs advises that there should be a process for secure collection, avoiding, for reasons of public health, that drug residues are not accessible like any other household waste. In 2012, the *Valormed,* Azores, managed to collect 7.4 tons of medicine waste.

These systems were included in the questionnaire since they are closely related with several types of residues linked to farming (SRRN, 2013).

Ecoponto Amarelo, the container located at *Ecopontos* devoted to non-hazardous plastic and metal packaging material was also included, since there are records of packaging material originating in farms that was deposited at this type of container and also at the container devoted to undifferentiated urban waste.

Validation of the questionnaire

The validation of the questionnaire went through a pre-test in order to correct possible flaws both in writing an in item formulation, and notice if there were difficulties in the interpretation of questions. The questionnaire was applied to twenty farmers who indicated some shortcomings in the writing, and the difficulty of utterance interpretation and concentration to give the answers. Given this information, the necessary reformulation was implemented.

Procedures for Data Collection

São Miguel Island Farmers Association was contacted to facilitate access to farmers. All farmers participated voluntarily and received no payment for doing so. Data collection was from June 4 to July 31, 2013. The sample included 104 farmers from the Island of São Miguel, Azores (maximum error margin, 4.9%).

Results

Sample Characterization

The study sample consists of 104 farmers from the São Miguel island, Azores, all male, with ages ranging from 18 to 66 years of age (average = 40.12 years, s.e. = 1.26 years), and the most frequent age classes correspondent to 20 to 30 and 40 to 50 years. Of the farmers surveyed, the majority said that as academic qualifications they had complete basic education (grade 9) (58.7%) and the remaining had lower qualification (23,1%), in general. Of the total respondents, 30.8% lived in Ribeira Grande and 30.8% in Nordeste municipalities. The remaining were distributed through Ponta Delgada (25%) and Lagoa (13.5%) municipalities. Turning to training, almost 100% of the sample had no specific training/education (98.1%), adding to this situation the fact that they own family businesses, passed from generation to generation. In relation to the professional activity, again almost all of the individuals surveyed claimed to have as professional activity only agriculture (99.0%), which is the general situation in the Azores (GPSRAF, 2011).

Final destination given to target waste types by farmers

What is the concern of farmers towards the environmental impact of the waste produced in their activity?

It was found that more than two thirds of the farmers agreed that the waste generated in agriculture can adversely affect the environment, that waste generated in farms is not environmentally friendly, and that farmers are conserned about the destination given to waste generated in agriculture. On the other hand, three quarters disagree with the statement that the final destination of each residue is common knowledge among farmers (Figure 1).

Do farmers distinguish the different types of waste?

With regard to this point, almost half of respondents disagree that the waste generated in agriculture are all of the same type, and to emphasize that, about 30% strongly disagree with the statement. On the other hand, almost 90% of farmers agreed that they do not quite know where to deposit some types of waste. However, nearly three-quarters of farmers agreed that there are types of waste that can be more harmful to the environment (Figure 2).

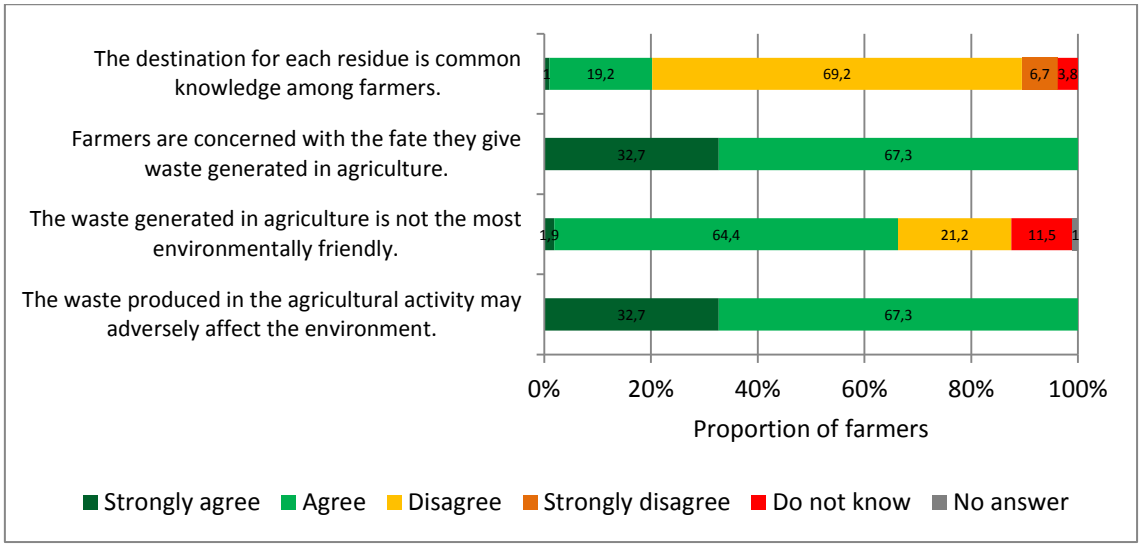

Figure 1. Results obtained from a sample of 104 farmers in São Miguel Island, Azores, regarding four items relative to the research question: *What is the concern of farmers towards the environmental impact of the waste produced in their activity?*

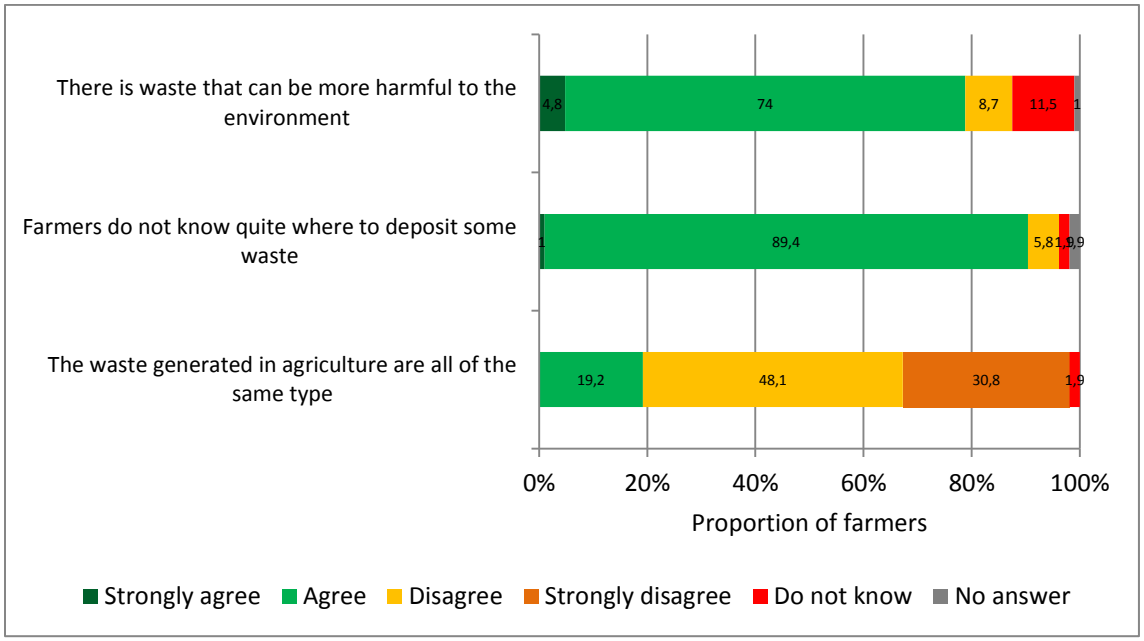

Figure 2. Results obtained from a sample of 104 farmers in São Miguel Island, Azores, regarding four items relative to the research question: *Do farmers distinguish the different types of waste?*

What is the legal knowledge of farmers about waste disposal?

In this case, it was found that more than half of the farmers stated that they do not know whether there is legislation covering the proper disposal of waste. Similarly, almost half of respondents did not know if the law applicable to waste on farms is adequately disclosed, and more than 40% disagree or strongly disagree with that statement (Figure 3).

What is the knowledge of farmers regarding the disposal of waste?

Regarding this question, more than 75% of the farmers agree that there are adequate procedures for the deposition of each type of waste. Likewise more than three quarters of respondents agree that waste is disposed of in accordance with its type. On the other hand, farmers disagree that they know how residues are treated after collection by the competent authority (Figure 4).

Why farmers do not correctly dispose of waste?

Over 95% of farmers stated that sometimes they don't have time to dispose of the waste properly. However, more than 90% of the respondents disagreed that is not very important to dispose of waste properly. On the other hand, almost half of respondents did not know if the responsibility of directing the waste is from the farmer (Figure 5).

What is the willingness of farmers to change their waste disposal habits?

Regarding this item, more than 80% of the farmers agree that they can also participate in a more appropriate waste disposal (Figure 6).

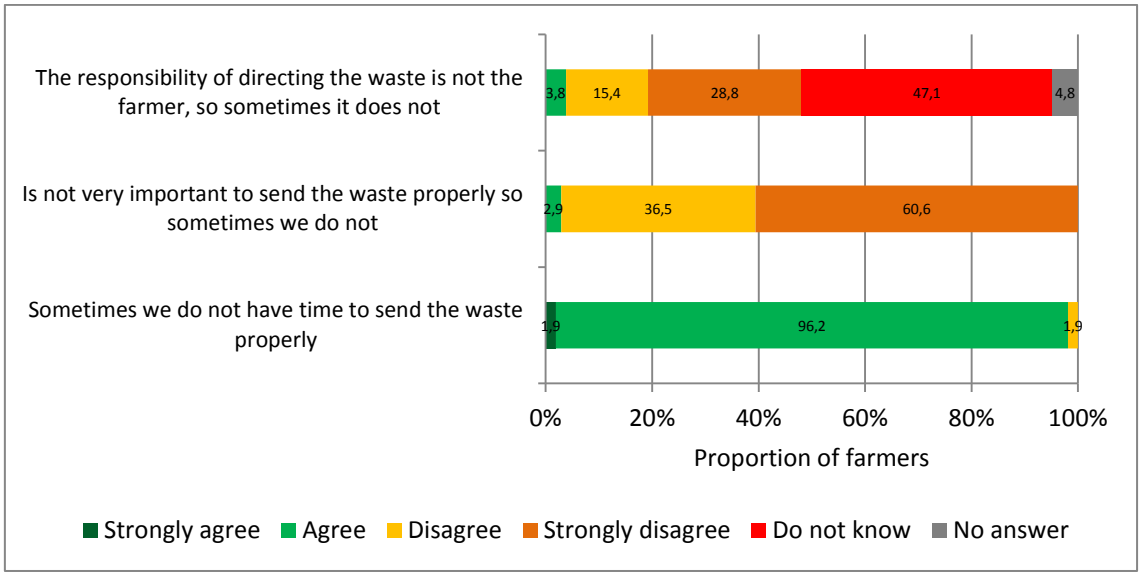

Figure 3. Results obtained from a sample of 104 farmers in São Miguel Island, Azores, regarding two items relative to the research question: *What is the legal knowledge of farmers about waste disposal?*

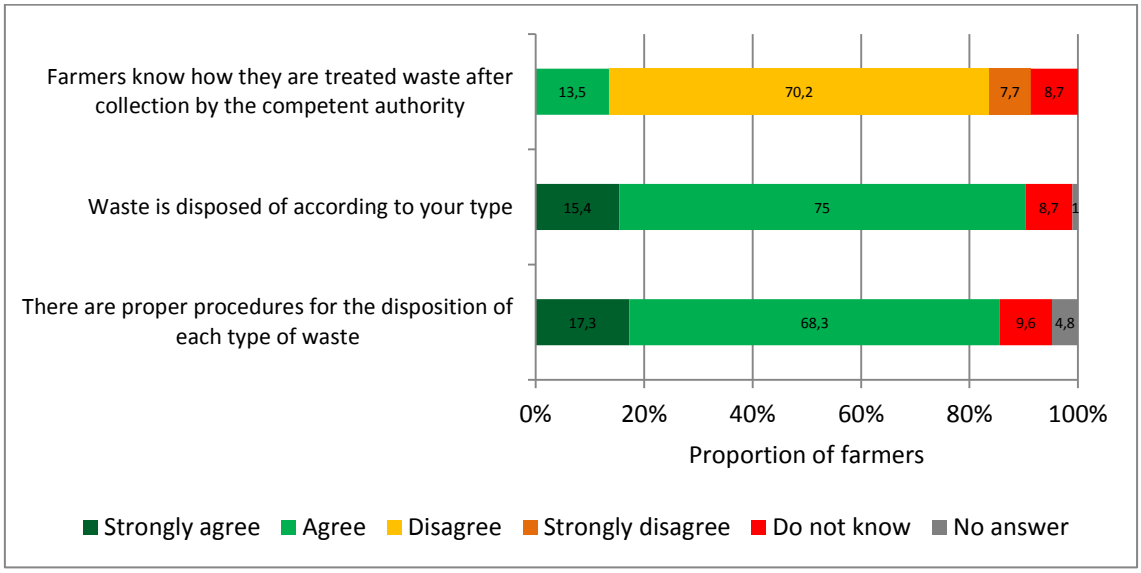

Figure 4. Results obtained from a sample of 104 farmers in São Miguel Island, Azores, regarding two items relative to the research question: *What is the knowledge of farmers regarding the disposal of waste?*

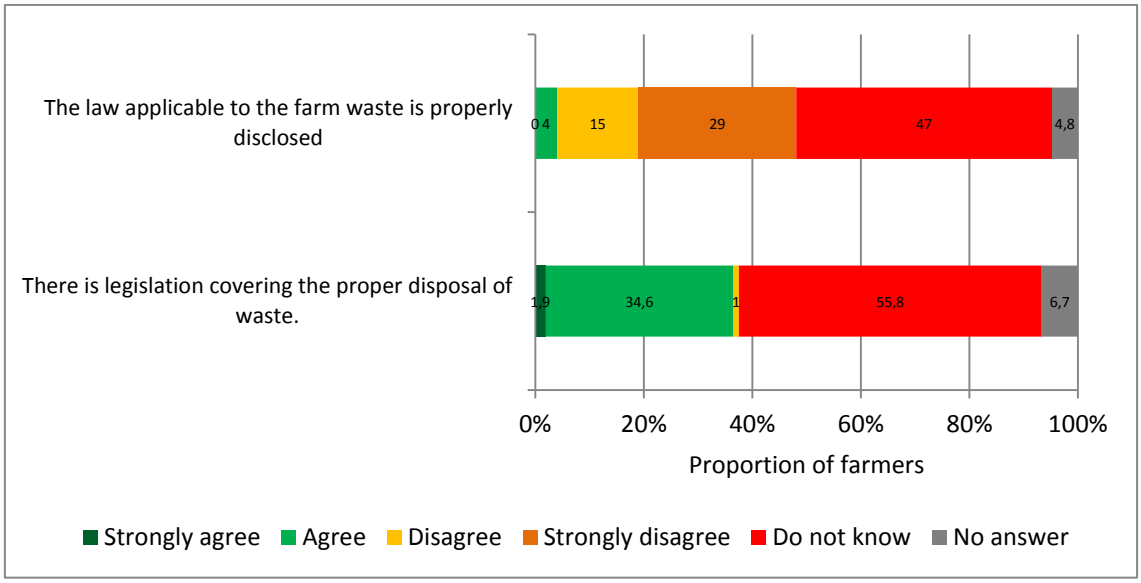

Figure 5. Results obtained from a sample of 104 farmers in São Miguel Island, Azores, regarding two items relative to the research question: *Why farmers do not correctly dispose of waste?*

More than two thirds of farmers agree that they are available to properly dispose of waste, provided they are informed. However, about one third of the farmers are not sure about this possibility. Although more than one third of the farmers agree that they are available to improve waste treatment, one third disagrees and more than one fifth don't know if this is true (Figure 6).

Impact

According to farmers, the type of waste which is produced in larger amounts is plastics. The type of waste which is produced in smaller quantities is mineral oils. The type of waste considered as more harmful was plastic, followed by mineral oils. Although the residue considered less dangerous was glass packaging, some the farmers also mentioned used tires (Figure 7).

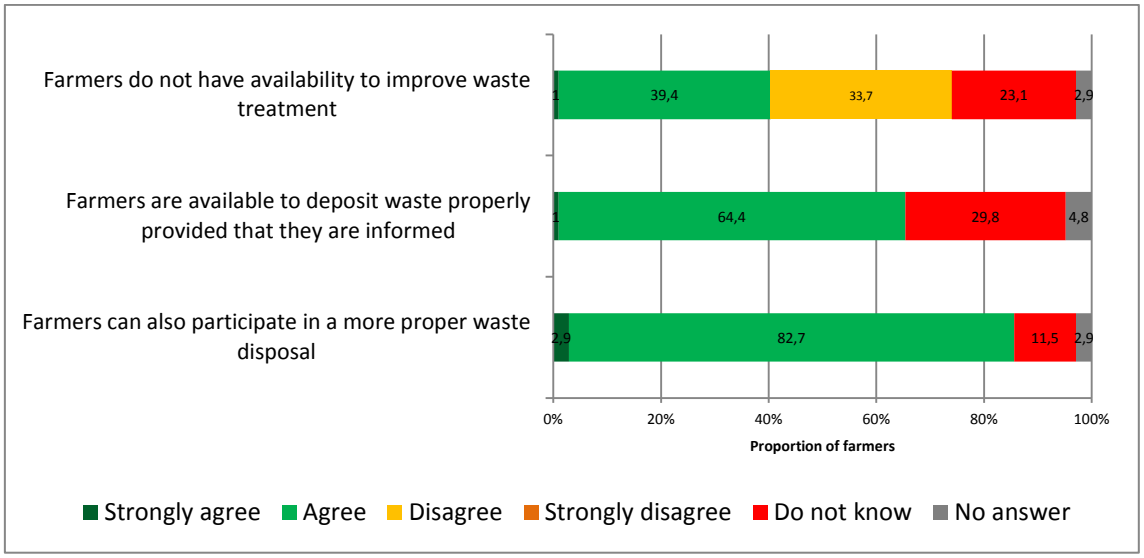

Figure 6. Results obtained from a sample of 104 farmers in São Miguel Island, Azores, regarding two items relative to the research question: *What is the willingness of farmers to change their waste disposal habits?*

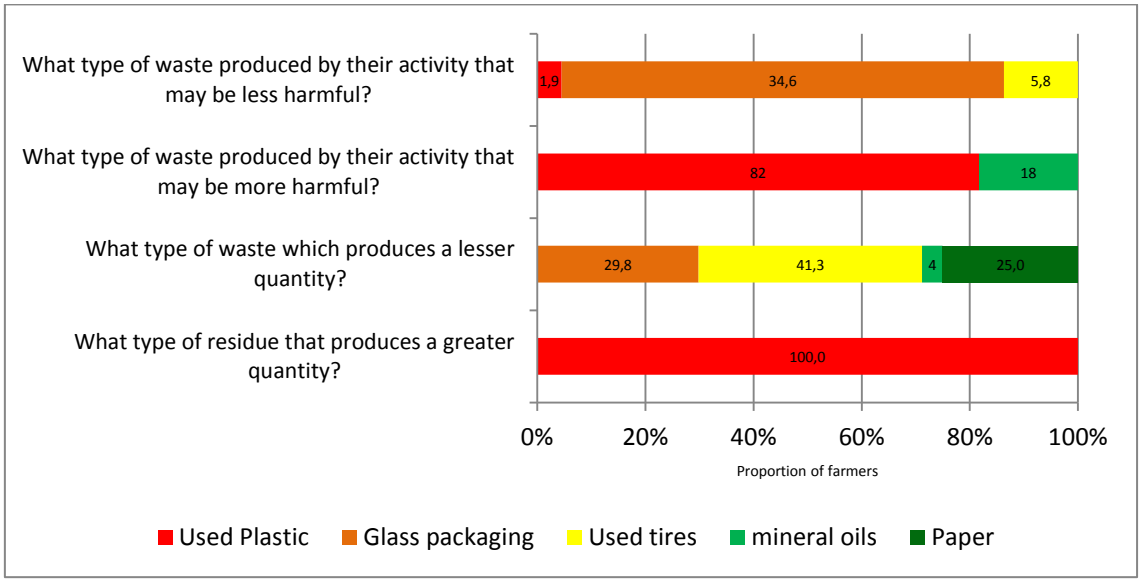

Figure 7. Results obtained from a sample of 104 farmers in São Miguel Island, Azores, regarding four items relative to the research question: *Impact of waste produced in agriculture.*

Final destination

Regarding the destination of the different types of waste, it was found that for five of the cases studied (plastic packaging, plastic used on crops and storage, containers of phytosanitary products, and packaging of veterinary products) more than 75% of farmers stated that the final destination was placement at a collector of municipal solid. Differently, it was found that used tires are mostly burned in the open while minerals oils are mostly left in the soil (Figure 8).

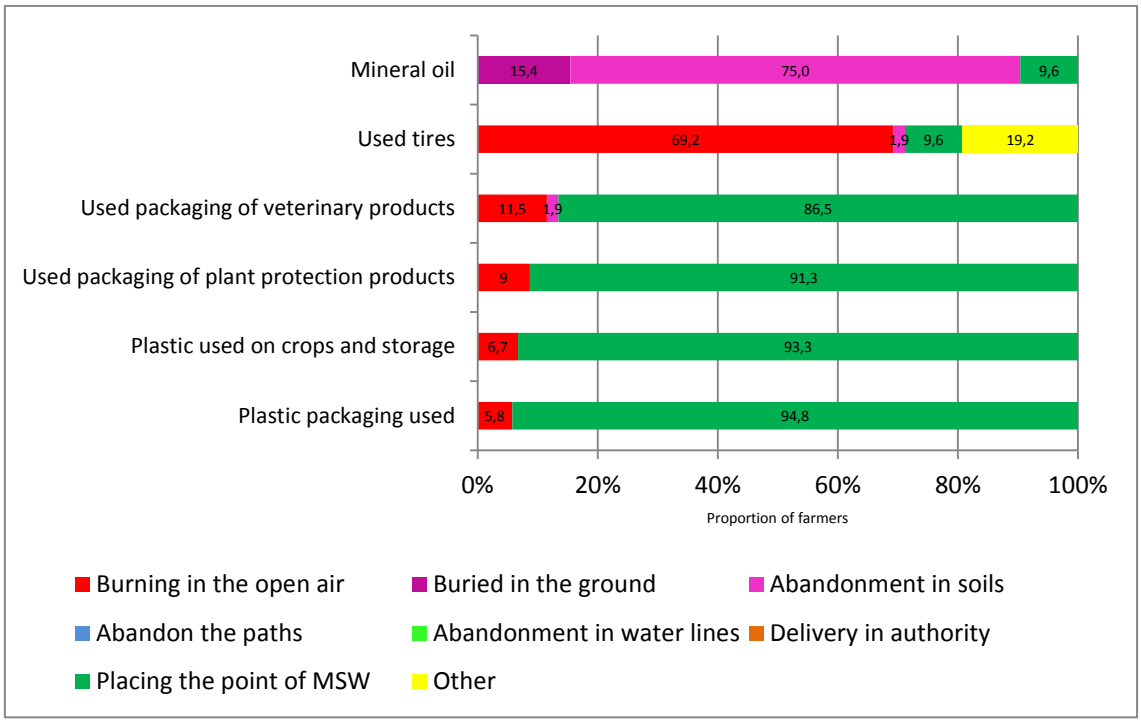

Figure 8. Results obtained from a sample of 104 farmers in São Miguel Island, Azores, regarding four items relative to the research question: *Destination of the different types of waste.*

Knowledge about the entities responsible for the treatment of various types of waste

The overwhelming majority of respondents, above 90%, stated not knowing about any of the entities that manage each specific residue (Figure 9).

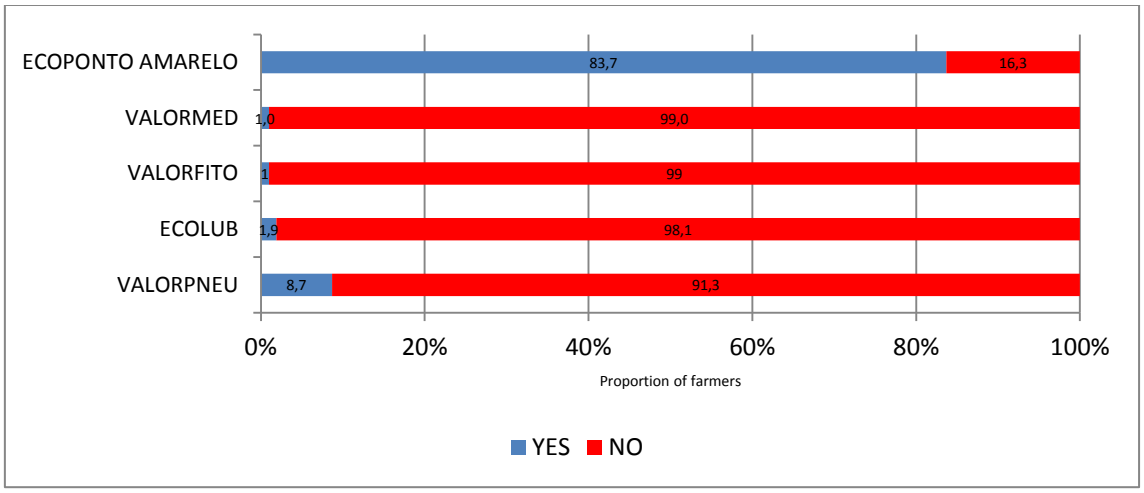

Figure 9. Results obtained from a sample of 104 farmers in São Miguel Island, Azores, regarding four items relative to the research question*Knowledge of the entities responsible for the treatment of various types of waste.*

The only exception was found in the case of *Ecoponto Amarelo* that the overwhelming majority (83.7%) of respondents stated to know.

Discussion

Regarding specific types of residues, our findings, although in agreement with previous studies, are nonetheless the cause for an objective concern in the regional authorities.

In the veterinary products respect, similar results were found in the USA (Seehusen & Edwards, 2006), in England (Bound & Voulvoulis, 2003) and New Zealand (Braund, *et al.*, 2009): most people deposit waste medicines in the trash and/or sewage (depending on the studies and on the pharmaceutical form), followed by a much smaller percentage delivery in the pharmacy. Also in Kuwait, Abahussain & Ball (2007) found that almost all respondents disposed of this kind of waste in the general trash. A very similar situation was found in our sample of Azorean farmers. Operational measures will have to be taken in order to make farmers aware of the proper ways to dispose of veterinary and phytosanitary packaging materials.

Used lubricating oils are considered as hazardous wastes due their properties, namely the presence of heavy metals, the most representative: lead, zinc, copper, chromium, nickel and cadmium, nonmetal particles, chlorinated compounds and other residues (Sohn, 2011). According to Willing (2001) one liter of used lubricating oil causes irreversible damage to one million liters of water and can take up to 300 years to degrade. The direct combustion of lubricants used without any pretreatment is subject to environmental constraints, because these oils contain hazardous waste products (El-Fadel & Khoury, 2001). Thus, the reality seen in our sample of Azorean farmers is clearly a case for concern for the regional authorities. Used mineral oils are supposed to be collected by SOGILUB - Society for Integrated Management of Used Lubricating Oils, Inc. (ECOLUB), the management entity of the Integrated Management of Used Oils, constituted under Decree law n.º 153/2003, of July 11, which establishes the legal

framework for the management of used oils, having been licensed for Portugal, including the autonomous regions of the Azores and Madeira. Since there is a management system in place and considering the consequences of undue disposal procedures, operational measures are in order to change farmer's behavior.

The case of used tires improperly disposed in public places or vacant land requires special attention. In addition to these materials constituting an environmental liability, being significant components in solid waste generation, their undue deposition may result in a serious risk to public health because they can serve as breeding grounds for micro and macro vectors (mosquitoes) of diseases. Moreover, when burned in the open, these material release carbon, sulfur dioxide and other air pollutants, and each tire releases about 45.46 liters of oil that can percolate through the soil to reach ground water, contaminating it. Still, when disposed in landfills, because of their low compressibility, tires reduce the life of existing landfills, but also by absorbing the gases released by the decomposition of wastes, can swell and burst the coverage of these landfills (Cimino & Zanta, 2005). Again, since a system for used tire recovery is in place in the Azores, measures have to be taken to involve farmers.

In the case of plastic, it appears that much of the waste is deposited at the general municipal solid waste collector for undifferentiated waste. These in turn go to landfill. Although in the Azores all landfills are design to isolate the waste from the surrounding environment, especially the contact with groundwater, deposition of plastic materials in a landfill does not contribute to the desirable increase of plastic recycling and to the reduction of the amount of waste going to the landfills. Since farmers state to be familiar with the *Ecoponto Amarelo*, the appropriate collector for regular plastic waste

should be encouraged to deposit all adequate plastic (non-hazardous) materials at those structures.

Although farmers stated that it would be important give waste an adequate final destination, their verbalized behavior towards waste deposition showed that they frequently do not assume the most adequate procedures. Several aspects are probably linked to this, apparently, contradictory situation:

- The legal knowledge of most of the farmers on waste management was practically non-existent. This is probably due to a lack of effective information mechanisms. This can also be related to the fact that most farmers stated not to have specific professional training. To reverse this situation, it is important that competent authorities and the farmers associations develop concrete actions to make waste management legislation known to farmers. The heterogeneity of agricultural waste, both in volume and in geographical focus, partly demands the intervention of environmental or agricultural authorities in the matter. For example, in Spain (Catalonia), where there are high livestock concentration areas, governments have implemented many measures to correctly orient the management of manure and slurry, in order to minimize the negative impacts on natural resources. In Spain (Andalusia), there have also been significant efforts to channel the wastes from intensive horticulture and oil production. In other areas, this question still becomes unsolved. In some cases, local authorities allow the introduction of certain residues in the domestic circuit, due to the absence of operational alternatives (MAAMA, 2012).
- This study came to the conclusion that, in some case, farmers do not forward correctly waste for lack of time. This lack of time may indicate no concern or

even lack of knowledge about proper treatment, since most of the respondents did not know the proper destination of certain residues, as mentioned above. To act in this situation, it is necessary to organize awareness campaigns and thematic seminars, open to all farmers and to use teams that go to the fields to inform them. However, it is curious that, despite not knowing the right destination that should be given to waste, respondents find it important to dispose of it properly. To overcome this situation, in France (Les Vosges, Lorena) officials together with farmer's representatives organized a collection of plastics. Along with farmers a net of collection points located in cooperatives and especially on farms was established. The participation of these farms was voluntary, but was compensated by a lower effort involved in the transport of waste, allowing farmers to deposit their plastic waste properly separated (MAAMA, 2012).

- The overwhelming majority of respondents stated to know that there are correct procedures regarding the deposition of each type of waste and that waste is disposed of in accordance with its type. However, respondents stated not to know how waste is treated after collection by the competent authority. To broaden their view on the importance of using the appropriate pathway to dispose of waste, study visits to sites where appropriate treatment is performed could be organized. In Spain (Pilar de la Horadada), to solve the problems caused by plastic waste in the municipality, the City Council in 1997 initiated a pilot agricultural plastics management, together with the Ministry of Environment of the Generalitat Valenciana. Compliance and source separation of waste have improved significantly since the beginning of the experience.

Farmers have become used to carry waste generated as a certain volume, leaving various waste piles on the farm, which favors the separation (MAAMA, 2012).

- In this study, nearly half of the sample stated are able to distinguish the different types of waste, knowing that some are more harmful than others. However, most farmers do not quite know where to deposit some types of waste. Again, this reveals the lack of information that was already discussed above.
- It was also found that more than half of farmers showed readiness to change their habits, i.e. dispose of waste using the right procedure. However, about forty percent of the sample claimed to have no availability to improve the treatment of waste. Again, awareness campaigns or the implementation of systems that help farmers to comply are needed. In Spain (El Ejido), since its inception in 1993, the commissioning of a waste treatment plant has been supported by major sensitization and awareness campaigns. This work has been developed through several ways: outreach in schools, TV and radio, publishing brochures and authorized agents listings. After 15 years, the balance is positive (MAAMA, 2012): the rural health has improved considerably in the municipality; dropouts and uncontrolled fires are dwindling; the delivery of the waste to the plant and has been integrated into the production process.
- Analyzing the results it is possible to verify that according to the respondents the type of waste produced in higher amounts is plastic, while that produced in smaller quantities are used tires. Interestingly, farmers considered that the more toxic residue was plastic, while the least toxic waste was glass. As in any business, it is important for farmers to know exactly what wastes they are generating and their level of hazardousness. Once wastes products are generated

by an economic activity, it is the responsibility of the owners to properly manage and dispose of those residues. Ignorance about the hazardousness of waste produced in agriculture might lead not only to environmental problems but also to occupational health issues.

Operational programs devoted to increase awareness and to establish mechanisms facilitating and stimulating better waste management practices by farmers have to be implemented in the Azores, following examples developed in other regions: “Changing the attitude towards farm waste” (NRN, 2013).

In addition to the above, Political strategies to reduce negative environmental effects of agriculture can be divided into injunctions such as inhibitions and precepts, and into voluntary approaches. These two substantially different approaches were studied in the German Federal state of Baden-Württemberg, using as examples the Market Release and Landscape Conservation Programme (MEKA, voluntary), and the regional Regulation for Water Protection Areas (SchALVO, compulsory) respectively. The most significant results would indicate that the acceptance of voluntary programs is based on an appropriate financial compensation for the required adjustments. If this is the case, this kind of program would appear to have the same acceptance as injunctions. In general, the farmers have positive attitudes towards voluntary approaches, but the supervision mechanisms are also growing as a function of the loss of influence felt to exist within these approaches (Baudoux *et al.*, 1998).

Concluding remarks

The management of waste is one of the pillars on which to based a strategy for sustainable development in the Azores, through the implementation of PEGRA. However, based on our results it is important that, in the future, the political authorities and other entities like farmer's association have a more pro-active attitude on the management of waste from agriculture. In this context, the Association of Municipalities of São Miguel Island (AMISM) was interested in understanding how farmers presently manage the non-organic residues resulting from their economic activity.

Taking into account the results presented in this study, it was found that it is necessary to implement an information system or awareness tool, for farmers to increase their knowledge about the waste management system applicable in the region, and adopt more environmentally friendly practices that comply with the present legislation.

It was found that farmers are available to change their habits and that they show concern about the final destination given to waste, so there is the urgent need to make operational tools available to farmers allowing them to change incorrect behaviors.

This study concluded that the legal knowledge of the majority of farmers in what concerns waste management is reduced. This is most probably due to the lack of effective mechanisms for training farmers in issues related to the environment. Clearly, it is fundamental that farmers become aware that they have a responsibility on the correct disposal of the waste they produce, something that according to our findings is not clear for a considerable portion of the respondents.

Most farmers are apparently not aware of the most hazardous residues they produce in their activities, since they considered plastic as the most hazardous material. For

environmental and also for occupational health reasons, it is fundamental that the level of hazardousness of each residue becomes familiar to all the farmers.

Our results also point out to the possibility of a considerable portion of the residues end up in collectors for undifferentiated urban waste, thus being sent to landfill. This is a problem since some of those residues could be recycled and others should be sent to appropriate entities. Of more concern is the fact that tires are burned and mineral oils end up in soils.

Clearly, much has to be done in order to profoundly improve waste management practices in Azorean agriculture, the most important economic activity in the Azores.

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ANEXO I

v

Universidade dos Açores
Mestrado em Ambiente, Saúde e Segurança

Questionário da pesquisa

Favor marcar com um **X** somente em uma única resposta que melhor se apresente para si.

1. Sexo:

☐ Masculino ☐ Feminino

2. Faixa de idade:

☐ Até 20 anos ☐ De 20 a 30 anos ☐ De 30 a 40 anos

☐ De 40 a 50 anos ☐ De 50 a 60 anos ☐ Acima de 60 anos

3. Concelho de Residência

☐ Ponta Delgada ☐ Ribeira Grande ☐ Vila Franca do Campo

☐ Povoação ☐ Lagoa ☐ Nordeste

4. Habilitações literárias

☐ Ensino básico incompleto ☐ Ensino básico completo ☐ Ensino secundário

☐ Ensino secundário ☐ Ensino superior

5. Formação profissional

☐ Não teve ☐ Teve apenas informal ☐ Teve um curso formal

6. Atividade profissional

☐ Apenas agricultura ☐ Agricultura principal ☐ Outra | Qual? _____

7. Favor responder a este questionário considerando sua percepção ou opinião quanto às afirmativas, circulando o número que corresponda ao seu grau de concordância.

1 - Concordo totalmente 2 - Concordo 3 - Discordo 4 – Discordo totalmente 5 – Não Sabe						
01	Os resíduos produzidos na atividade agrícola podem afetar negativamente o ambiente.	1	2	3	4	5
02	Os resíduos produzidos na atividade agrícola são todos do mesmo tipo.	1	2	3	4	5
03	Há legislação que abrange a eliminação correta dos resíduos.	1	2	3	4	5
04	Há procedimentos corretos para o destino a dar a cada tipo de resíduo	1	2	3	4	5
05	Os agricultores não sabem bem onde depositar alguns resíduos.	1	2	3	4	5
06	Os agricultores podem ainda participar mais num correta deposição dos resíduos.	1	2	3	4	5
07	Os resíduos produzidos na atividade agrícola não são dos mais nocivos para o ambiente.	1	2	3	4	5
08	Há resíduos que podem ser mais nocivos para o ambiente.	1	2	3	4	5
09	Há legislação que abrange a eliminação correta dos resíduos.	1	2	3	4	5
10	Os resíduos são eliminados de acordo com o seu tipo.	1	2	3	4	5
11	Por vezes não temos tempo para encaminhar os resíduos corretamente.	1	2	3	4	5
12	Os agricultores estão disponíveis para depositar os resíduos corretamente, desde que sejam informados.	1	2	3	4	5
13	Preocupa-se com o destino que dá aos resíduos produzidos na atividade agrícola.	1	2	3	4	5
14	A legislação aplicável a resíduos nas explorações agrícolas é devidamente divulgada.	1	2	3	4	5
15	O destino certo para cada resíduo é do conhecimento geral dos agricultores.	1	2	3	4	5
16	Não é muito importante encaminhar corretamente os resíduos por isso, por vezes, não o fazemos.	1	2	3	4	5
17	Os agricultores não têm disponibilidade para melhorar o tratamento dos resíduos.	1	2	3	4	5
18	Os agricultores conhecem o modo como são tratados os resíduos após recolha pela entidade competente.	1	2	3	4	5
19	A responsabilidade de encaminhar os resíduos não é do agricultor, por isso, por vezes não o faz.	1	2	3	4	5

8. Favor responder às respostas abaixo, considerando a sua perceção ou opinião quanto às afirmativas. Favor marcar com um X somente em uma única resposta que melhor se apresente para si.

Tipo de resíduo	**Queima a céu aberto**	**Enterra no solo**	**Abandona no solo**	**Abandona nos caminhos**	**Abandona em linhas de água**	**Entrega à entidade responsável**	**Coloca nos pontos de recolha de RSU**	**Outro, qual?**
Que destino dá às embalagens de plástico já usadas?								
Que destino dá ao plástico usado nas culturas e no armazenamento?								
Que destino dá às suas embalagens usadas de produtos fitofarmacêuticos?								
Que destino dá às suas embalagens usadas de produtos veterinários?								
Que destino dá aos seus pneus usados?								
Que destino dá aos seus óleos minerais usados?								

9. Favor responder de forma sucinta às questões que seguem abaixo:

Qual o tipo de resíduo que produz em maior quantidade?

_____

Qual o tipo de resíduo que produz em menor quantidade?

_____

Qual o tipo de resíduo produzido pela sua atividade que poderá ser mais nocivo?

_____

Qual o tipo de resíduo produzido pela sua atividade que poderá ser menos nocivo?

_____

10. ***Qual o seu conhecimento sobre as entidades de gestão de resíduos.*** Favor marcar com um X somente em uma única resposta que melhor se apresente para si.

Entidade/Estrutura	**Sim**	**Não**
VALORPNEU		
ECOLUB		
VALORFITO		
VALORMED		
Ecoponto Amarelo		

Muito Obrigado pela Sua colaboração!!!