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POTENTIAL ADOPTION OF THE BEST INNOVATIVE SOLUTIONS IN AGROFOOD VALUE CHAINS:

HORTICULTURAL: SPAIN

DAIRY: ITALY

MEAT: FRANCE

Index

1. POTENTIAL ADOPTION OF THE BEST INNOVATIVE SOLUTIONS IN THE HORTICULTURAL PRODUCTION

1.1. INTRODUCTION

Nowadays, new ideas can transform any step of a value chain; innovations in products and services represent only the tip of the iceberg in innovation as a concept (Birkinshaw et al, 2011). In this sense, the Oslo Manual is the guide produced by the Organization for Economic Cooperation and Development (OECD, 2019) to allow the collection and interpretation of information on the innovative activity of companies. According to this manual, there are four levels of innovation: processes, products, markets and organization (Figure 1):

Figure 1.1. Levels on innovation

Source: Own elaboration from the Oslo Manual (2019)

Adoption is the process by which producers decide to incorporate into their production systems new techniques that have been generated and developed by certain research and development (R&D) entities. In general, there is a direct relationship between the adoption of new technologies or products and the economic, technical and environmental benefits derived from their use. In this sense, when the farmer or producer does not consider that these advantages exist in the products or technologies offered to him, he simply decides not to adopt them. On the other hand, it is important

to remember that the non-adoption of innovation by the producer may be due to exogenous factors such as the availability in the supply, the high cost of alternative materials, the lack of sustainable alternatives, lack of its knowledge by farmers and companies, etc. Therefore, strategies are needed to minimize the limiting factors in the adoption process and to promote the factors that promote or favor such a process.

The adoption rate is an indicator that shows the number of producers who are willing to continue with the innovative products or processes when the technical assistance or information/trial period has ended. It is defined as the relative rate or speed at which members of a social system adopt an innovation. The rate of innovation is determined by the type or category of adoption of an individual (in this case a horticultural producer). In general, producers who adopt an innovation first (pioneers) require a shorter period of acceptance or approval than those who adopt it later (Rogers, 2003).

Several studies confirm that the adoption of innovation, is a key element in achieving greater competitiveness and added value in agri-food production systems. Some studies have tried to clarify the determining factors of innovation, as well as those that promote its rejection (Sánchez and Spiet, 2013). Among them, it is worth noting how research in relation to innovation in the agricultural sector has focused more on the analysis of adoption rates than on understanding the process followed by producers in their specific environment to adopt such innovation (Sánchez and Spiet 2013; Gavilán et al. 2019).

In general terms, innovation in a given agrifood value chain could be carried out by:

- Obtaining and introducing new products to the market.

- Changing in the equipment and production processes of the agri-food company. As a concept, the adoption of innovation is a set of successive stages in the decisions of producers (in our case, greenhouse growers) to decide whether to accept or reject innovation (Gatignon and Robertson, 1991). Therefore, it is important to identify the level of knowledge and information that farmers have about the innovations that are appearing on the market. According to Rogers (1962), such adoption is the set of mental stages in a process of reflection of the individual from the moment he knows about the existence of the innovation, until he adopts or not it.

Adoption comprises two key aspects: risk in choice and knowledge acquisition. The risk involved in the process of adopting innovation decreases as the farmer's knowledge increases. The decision, therefore, will depend on the knowledge of the different conditioning parameters that the producer has and, therefore, strategies based on these factors could favor the adoption of the innovation.

In this innovative process, different time stages are defined, which are the following:

- *Knowledge:* for the first time, the owner of the agri-food company knows about the innovation, but with hardly any information.

- *Interest:* this is the period in which the owner of the agri-food company improves and increases

knowledge with additional information (new materials, techniques, process, etc.).

- *Evaluation:* in this phase, the owner proceeds to order the information received and to estimate its validity considering its conditions and context, taking into account the advantages that it could provide, its potential costs and its useful life.

- *Test*: the owner takes the decision to try and test a certain innovation on a small scale in his company in order to personally verify its results on site.

- *Adoption:* it refers to the definitive introduction of the innovation in the company.

In this context, within the framework of the REINWASTE project, different innovative solutions (also called BATs, Best Available Technologies) have been identified to reduce and mitigate the problem and impact of inorganic waste generated in three agri-food value chains (dairy in Italy; horticulture in Spain; meat in France). Among these, several pilot trials have been selected to be implemented in the field and in industry.

In the horticultural sector the following information have been identified and evaluated:

- The degree of concern and knowledge of horticultural farmers/producers/businesses about the problem of inorganic waste in general.

- The degree of knowledge of the innovative solutions available in the market to reduce inorganic waste in each step of the horticultural value chain.

- The level of knowledge of the five pilots tested at the primary horticultural sector level and their corresponding alternative solutions in the framework of the REINWASTE project.

- The potential for adoption of these tested pilots with alternative solutions for the horticultural sector.

- The limiting factors for the adoption of these alternatives (socio-economic, environmental, and technical) by the sector.

- The promoting factors that encourage and favor the adoption of these alternatives by the sector (socio-economic, environmental, and technical).

- The strategies that can be developed to promote and encourage the adoption of the alternative solutions tested with the pilots for the horticultural sector.

1.2. METHODOLOGY

The information used to analyze the potential for adoption in the horticultural production sector was obtained from a survey of six experts of the horticultural sector. These experts were chosen of

the following profiles: two researchers, two technicians from the sector and two managers. The surveys were carried out during the first half of February 2020. The results of this study are therefore based on the 'expertise' and 'background' that the experts have on the sector and on the innovative solutions that potentially reduce or minimize waste, as well as on a review of diverse literature such as articles, reports, etc. on the subject.

A pilot survey was carried out previously to verify the correct adaptation of the survey and to be able to make certain changes if necessary, before executing the final survey. The survey carried out is structured in the following blocks (see Annex 1 for more detailS):

(i) Level of concern and knowledge of the sector about the problems of inorganic waste and alternative market solutions.

(ii) Level of knowledge of the alternatives tested in the pilots of the REINWASTE project in the horticultural production sector.

(iii) Potential for adoption of the alternatives tested in REINWASTE.

(iv) Limiting factors in the adoption of innovations in the horticultural sector. (v) Promotional factors in the adoption of innovations in the horticultural sector. (vi) Strategies to promote the adoption of tested pilot alternatives.

In order to quantify expert opinion on certain issues (importance, interest, level of agreement, etc.), the same scale has always been used, ranging from 1 (not important/not interesting, totally in disagreement, etc.) to 9 (very important, very interesting, very much in agreement, etc.). For the analysis of the data obtained, the information has been categorized as 'low' when the score is between 1 and 4, 'medium' when it is between 4 and 6 and 'high' for those scores over 6. The tested pilots and their correspondent studied alternatives are shown in Annex 2 for more detail. Likewise, this work presents only a qualitative-descriptive analysis of the most important results of the different blocks.

To obtain the results of the surveys, the corresponding analyses were carried out. The most important aspects of univariate and descriptive analysis are presented here in the form of means, standard deviations or coefficients of variation of the information generated by the surveys.

With regard to the programs used to process the survey data, Microsoft's Excel 2000 for Windows and the SPSS 20 program were used.

1.3. RESULTS

The following results are the description of the information obtained according to the opinion of the experts interviewed for the horticultural production sector. It should be emphasized that this information has been based on a scale from 1 to 9 as detailed in the methodology above.

III.1. Level of concern and knowledge of the inorganic waste generation in the horticultural production sector as a problem and the alternatives in the market

With regard to the problem of inorganic waste generation in the global context and specifically in horticultural production, the results of the obtained responses according to the degree of knowledge and concern of the sector are shown in Table 1.1

Table 1.1. Level of concern and knowledge of the sector about the problem of inorganic waste and alternative market solutions

	Average	SD	CV (%)
Degree of general knowledge of the waste problem in the sector	7.17	1.33	18.5
Level of concern about the problem of inorganic waste generated in the sector	6.67	1.21	18.2
Degree of knowledge of alternatives available on the market to reduce inorganic waste	5.33	1.75	32.8

Source: Own elaboration from the survey carried out within the framework of the REINWASTE project (2020).

As it can be seen from the data collected through the survey, the sector's knowledge of the existing problem with regard to waste is high (average 7.17) and in the same way, concern about the generation of waste is also high (average 6.17). It is also important to highlight that there is a clear homogeneity in the opinion of the sector, given by a low coefficient of variation (CV). However, the sector's knowledge of the alternative solutions in the market to minimize, reduce or eliminate inorganic waste is medium (average 5.33).

Therefore, despite the high level of concern and knowledge of the sector about the problem of waste, there is a general lack of knowledge about more sustainable alternatives available in the market. This can be a very limiting factor in the shift towards possible innovations that may exist in the market.

III.2. Level of knowledge of the alternatives tested in the REINWASTE project pilots of the horticultural production sector

The results presented in this section are related to the direct knowledge that the sector has related to the alternatives tested in each of the pilots selected and executed within the framework of the REINWASTE project. The results are shown in Table 1.2.

Table 1.2. Knowledge of the alternatives tested in the REINWASTE pilots

Degree of knowledge of the tested alternatives

Use of alternative materials for plant staking raffia

	Average	SD	CV (%)
Use of compostable raffia 100% of natural origin	5.17	1.72	33.3
Use of reusable raffia	5.50	1.52	27.6
Use of biodegradable raffia (mixture natural and bio-polymer)	5.50	1.38	25.1
Use of alternative materials for plastic mulching			
Use of compostable plastic mulching	3.83	3	55.7
Use of in soil biodegradable plastic mulching	4.17	3	55.6
Energetic valorization of difficult-to-manage waste			
Valorization by gasification	3.00	1.26	42.2
Valorization by pyrolysis	3.17	1.47	46.5
Application of documentary traceability to waste management			
Use of a documentary traceability software	3.17	2.64	83.4
Use of a hard-copy based (physical) documentary traceability system	5.17	2.64	51.1
Associative waste management models			
The farmers' association becomes waste manager	3.17	2.14	67.5
Agreement farmers´ association-single management company	4.33	1.86	43.0

Source: Own elaboration from the survey carried out within the framework of the REINWASTE project (2020).

With regard to the knowledge that the sector has about the alternative materials of staking (raffia), it is necessary to emphasize that it is considered at a medium level for the three tested alternatives. In this sense, the staking alternatives of which the sector has a greater knowledge are reusable raffia and biodegradable raffia (both averages 5.50), followed by compostable raffia (average 5.17).

It is also necessary to highlight that, contrary to the staking raffia alternatives, the knowledge of those alternatives tested in the REINWASTE project regarding more sustainable types of mulching is considerably lower. In this context, according to experts, the sector has a medium-low knowledge of both biodegradable plastic mulching (average 4.17) and compostable plastic mulching (3.83). Consequently, more emphasis should be placed on disseminating knowledge about this type of new mulching materials, since it is also one of the functions that contribute most to the generation of waste in horticulture (see Sayadi et al 2019, 2020).

In relation to the energetic valorization of difficult-to-manage waste alternatives that currently exist, the knowledge that the sector has of these is low. Among them, the alternative of valorization by pyrolysis is better known than the alternative of valorization by gasification (3.17 and 3.00, respectively). We must once again stress the need to make this type of alternatives better known for the sector when managing waste that is difficult to treat, as it represents a major problem.

On the other hand, with regard to the alternatives tested for the application of a documentary traceability system for waste management, it is observed that the level of knowledge by the sector for the alternative of using a physical traceability system is medium-high (average of 5.17) and much higher than that related to the use of a traceability software, which is low (average of 3.17). Therefore, the knowledge of a waste traceability monitoring system by means of traceability software is hardly known, in spite of being potentially an effective way of monitoring and characterizing waste.

The knowledge that the sector has about the different associative models is also shown in Table 2. The existing knowledge about the simple associative model based on the agreement of farmers´ association and a single management company is medium (4,33). However, the alternative by which the farmers´ association becomes waste manager is very unknown (average of 3.17). This suggests that this step, in which the companies are the waste managers themselves, is perceived as difficult to achieve. Consequently, the sector considers that the alternative of an associative model of several companies with a single manager is more feasible, or at least better known.

III.3. Potential for adoption of the alternatives tested in REINWASTE

Through this question, the potential for adoption by the primary horticultural sector is evaluated through expert knowledge based on the different alternatives tested in the REINWASTE project and commented in the previous section. The results are shown in Table 1.3.

Table 1.3. Potential adoption of the alternatives tested in the REINWASTE pilots

Degree of potential implementation of the following alternatives of innovation			
Use of alternative materials for plant staking raffia			
	Average	SD	CV (%)
Use of compostable raffia 100% of natural origin	5.57	1.63	28.8
Use of reusable raffia	5.67	1.63	28.8
Use of biodegradable raffia (mixture natural and bio-polymer)	5.83	1.60	27.5
Use of alternative materials for plastic mulching			
Use of compostable plastic mulching	6.00	1.90	31.6
Use of in soil biodegradable plastic mulching	6.17	1.83	29.8
Energetic valorization of difficult-to-manage waste			
Valorización by pyrolysis	5.17	2.93	56.6
Valorization by gasification	5.17	2.93	56.6
Application of documentary traceability to waste management			
Use of a hard-copy based (physical) documentary traceability system	5.67	1.03	18.2
Use of a documentary traceability software	5.17	2.14	41.4
Associative waste management models			
The farmers' association becomes waste manager	4.67	1.97	42.1
Agreement farmers´ association-single management company	5.83	2.32	39.7

Source: Own elaboration from the survey carried out within the framework of the REINWASTE project (2020).

In the potential for adoption that the sector has with respect to the available alternatives for staking

or raffias, all obtain above 5.50, so there is a medium-high predisposition to use these new materials (averages of 5.57, 5.67 and 5.83 for compostable, reusable, and biodegradable raffia, respectively). Therefore, the problems generated by conventional raffia, especially in relation to the remains of these skating elements in vegetable waste (which make the treatment or composting of plant remains difficult), means that the sector has a high predisposition to adopt other types of raffia as alternatives to the conventional ones that solve or alleviate this problem.

The potential for adoption of alternatives to mulching by the horticultural sector is also high, with averages of 6.00 and 6.17 for compostable and biodegradable mulching, respectively. The potential for adoption of biodegradable mulch is again higher than for compostable mulch, as in the case of raffia, although this difference is in this case lower. It can be assumed that the `biodegradable´ concept is better known or more accepted by farmers and horticultural producers than `compostable´. Consequently, one can deduce the high predisposition to adopt these more sustainable mulching alternatives, at least in the short or medium term.

With reference to the potential for adoption of the alternatives for energetic valorization of difficult-to-manage waste tested in the project (valorization by pyrolysis and valorization by gasification), it should also be noted that the sector has a medium predisposition to adopt these techniques, in both obtaining the same average (5.17). It is therefore clear that the sector has a great need for innovative alternatives for this type of plastic waste that is difficult to manage and has a high impact in order to provide a solution for this type of waste.

With regard to the alternatives for documentary traceability of inorganic waste, the following aspects can be drafted. For both alternatives tested by REINWASTE, the predisposition to adopt them is medium, with 5.17 and 5.67 on average for the use of document traceability software and for a physical traceability system, respectively. Therefore, producers perceive the physical documentary traceability system as more feasible, possibly because at the moment there is no solid and developed software linked to the documentary traceability of the residues.

In relation to the alternatives related to associative models for waste management, the potential for adoption of both alternatives in the horticultural sector is medium, although it is also a fact that the sector is more inclined to adopt the alternative whereby companies establish waste management agreements with a single management company (average of 5.83). The alternative in which the farmers' association becomes waste manager does not have the same potential for adoption by the sector as the previous one (average of 4.67). Therefore, it is likely that the option of the company becoming its own waste manager is a possibility which is perceived as more complicated to achieve, possibly because of the relatively small size of the producers.

III.4. Limiting factors for the adoption of innovations in the producing horticultural sector

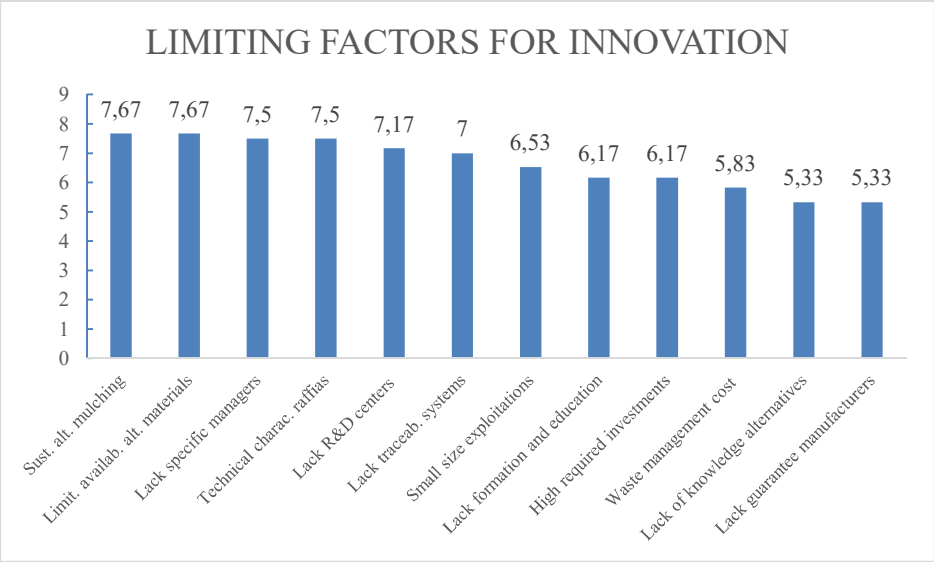
To start, it is important to highlight that all the limiting factors that have been proposed in the survey are all considered to be of medium-high importance, since all the average punctuation obtained have been greater than 5.00 (Table 1.4, Figure 1.2) according to the scale from 1 to 9 considered (see methodology).

Table 1.4. Limiting factors in the adoption of the alternatives for the reduction of inorganic waste

Limiting factors	Media	DE	CV (%)
Lack of knowledge from farmers about the innovative alternatives available in the market	5.33	0.52	9.70
Lack of guarantee and responsibilities from the manufacturers of the innovations respecting to their technical features	5.33	1.03	19.4
Management cost for certain kind of inorganic wastes	5.83	1.94	33.3
Lack of education and information background of producers respecting to waste management	6.17	1.47	23.9
High investments required for the implementation of innovative technologies	6.17	0.75	12.2
Numerous small size greenhouses with difficulties to assume their own waste management	6.53	1.47	21.5
Lack of some inorganic waste management traceability systems	7.00	1.26	18.1
Lack of research and innovation areas for minimizing waste at source	7.17	1.17	16.3
Lack of specific managers for certain inorganic wastes	7.50	1.52	20.2
Lack of proper technical characteristics with compostable and biodegradable raffia string	7.50	0.84	11.2
High cost and limited availability of alternatives materials at an affordable price	7.67	0.82	10.6
Lack of environmentally friendly alternatives of thin plastics	7.67	1.03	13.5

Source: Own elaboration from the survey carried out within the framework of the REINWASTE project (2020).

Figure 1.2. Limiting factors for innovation



Source: Own elaboration from the survey carried out within the framework of the REINWASTE project (2020).

Experts consider that aspects related to the training and education of producers are limiting factors of certain importance, since, despite the fact that it receives one of the lowest scores obtained, they are among the factors of high importance. These are in fact considered to be the factors with the lowest average scores of all the factors proposed (5.33 and 6.17 for " lack of knowledge from farmers about the innovative alternatives available in the market" and for "lack of education and information background of producers respecting to waste management", respectively). The sector also considers with some importance the lack of guarantee and responsibilities from the manufacturers of the innovations respecting to their technical features as limiting factors of medium importance (5,33), so the sector has some confidence in the guarantees offered by the producers of innovative alternative solutions.

One of the limiting factors that the sector perceives as being of high importance, according to experts, is the fact that many horticultural producers are relatively small in size to be able to take over waste management (average 6.53).

Furthermore, the lack of some inorganic waste management traceability systems is also perceived by the sector as a limiting factor of high importance (7.00). Therefore, it is necessary to develop strategies that implement traceability systems in the management, transport, and treatment of inorganic waste.

Below, the most important limiting factors for the sector are commented on, i.e. those that are very limiting, with averages above 7.00. The sector perceives the fact that there is a very low availability of alternative materials on the market to reduce inorganic waste in the sector, or even

that, if they do exist, their price is very high (average of 7.67), so this is a limiting factor of considerable importance.

In the same context, the lack of proper technical characteristics with compostable and biodegradable raffia string is also a very important limiting factor (average of 7.50). Therefore, and based on the perception that the sector has of the limiting factors for the adoption of innovation, more research and investment is needed in the development of alternatives that are environmentally viable, but also competitively priced.

In relation to the previous point, we must insist on the need to develop lines and programs of R&D which develop the creation of new materials which are more environmentally friendly, but which also guarantee access to these by farmers and producers by means of reasonable prices. In this sense, the lack of research and innovation areas to minimize waste at source is also perceived as a very important limiting factor (average of 7.17).

It is also of vital importance to develop a network of managers for waste that is difficult to manage (average 7.50), which works in a coordinated way in the logistics and treatment of waste.

In short, it is essential to continue developing R&D initiatives that support and respond to the above-mentioned limiting factors and that offer viable alternatives from an economic, environmental and social point of view.

III.5. Promoting factors for the adoption of innovation in the horticultural production sector

The results obtained in relation to the factors that promote the adoption of the alternative measures for a better management of inorganic waste are shown below (Table 1.5, Figure 1.3)

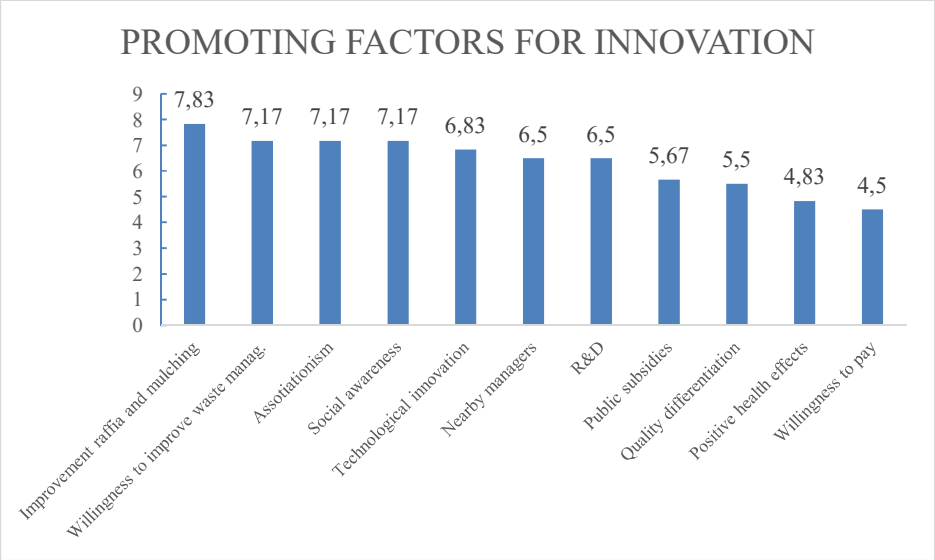
Table 1.5. Promoting factors in the adoption of the alternatives for the reduction of inorganic waste

Promoting factors	Average	SD	CV (%)
Increasing demand and willingness to pay more for sustainable products that reduce waste by consumers	4.50	1.76	39.1
The use of the alternatives to reduce the inorganic waste has positive effects on public health	4.83	2.04	42.2
Product differentiation linked to quality attributes of waste management “zero waste” and higher added value obtention and competitive advantage (opportunity market)	5.50	2.59	47.1

Existence of public subsidies for some innovative alternatives	5.67	2.25	39.7
Current research and innovation trends focused on valorization of waste, bio economy and circular economy	6.50	2.07	31.9
Presence of authorized agents close to production area	6.50	1.87	28.8
Technological innovation addressed in most of the companies to improve their efficiency using production resources	6.83	1.33	19.5
Willingness to improve inorganic waste management by producers and their associations	7.17	0.98	13.7
Associationism that favors the scale economy and willingness to encourage collaboration among companies to promote joint waste management investments and favor scale economy to reduce costs	7.17	0.75	10.5
Higher social awareness in the agri-food value chain regarding to waste's generation	7.17	1.17	16.3
Important technological improvement of biodegradable strings and mulching	7.83	0.75	9.61

Source: Own elaboration from the survey carried out within the framework of the REINWASTE project (2020).

Figure 1.3. Promoting factors for innovation



Source: Own elaboration from the survey carried out within the framework of the REINWASTE project (2020).

Respecting to the factors that promote the adoption of innovation, the sector perceives that those that are most important are technological improvement of biodegradable raffias and mulching (average 7.83) and the high social awareness in the agri-food value chain regarding to waste's generation (average 7.17). Therefore, society's widespread knowledge and concern about the environmental problems arising from the agri-food sector is perceived precisely as an important asset when it comes to innovation, since social demand is high and growing. Therefore, all those strategies that are directed towards the consumer and society in general, can be an important way to promote the adoption of more sustainable alternatives in horticulture.

Likewise, the experts affirm that the sector perceives as very important factors and that promote the adoption of innovation in the horticultural sector, the willingness to improve inorganic waste management by producers as well as favor the associationism among them for a collaborative waste management (averages both of 7.17). Therefore, all the technical measures and legal regulations that are developed should promote this trend and willingness to associate for a better and more efficient waste management.

The sector also considers as promoting factors of high importance (above 6 according to the scale), the current research and innovation trends focused on valorization of waste, bioeconomy and circular economy which is being carried out (average 6.50). With this same importance, the presence of authorized agents close to the production area for waste management is also

perceived by the sector as another factor of high importance in the adoption of innovative solutions and the improvement of sustainable management.

Product differentiation linked to quality attributes of waste management “zero waste” and higher added value obtention and competitive advantage, can create business opportunities and new market niches. This fact is perceived, at least in the short term among experts, also with medium importance (5.50). Similar to this punctuation, the existence of subsidies to encourage the adoption of some innovative alternatives and to alleviate their high cost is also perceived as being of average importance (5.67).

In the other hand, we can find those factors promoting innovation to which the sector gives less importance. Indeed, the increased consumer demand for sustainable products that reduce waste generation, as well as the increased willingness to pay for these, is perceived as one of the less important short-term drivers of innovation. Consequently, it is likely that the sector does not perceive that there is actually a high consumer willingness to pay higher prices for more sustainable products with respect to waste generation, or that it is not considered a major factor (average of 4.50).

Another prompting factor that the sector does not consider to be of some importance is the fact that alternatives to reduce inorganic waste can have a positive effect on public health. The actual relationship between environmental improvement and public health may not be as directly perceived, or not for this particular case of reducing inorganic waste (average 4.83).

III.6. Strategies to encourage the adoption of tested alternatives in the producing horticultural sector to reduce and/or minimize the generation of inorganic waste

According to the knowledge and 'expertise' of the experts who participated in this study, the horticultural sector demands or recommends the strategies shown in Table 1.6 to promote the adoption of the alternatives tested within the framework of the REINWASTE project and can be grouped into the following five blocks: (i) information and education, (ii) quality certifications, (iii) subsidies, and legislation, (iv) waste managers and collection points, and (v) various technical strategies.

Table 1.6. Strategies suggested by the experts in the sector for an improvement in waste management

1. Information and education: - Information transfer and awareness campaigns to the sector - Conducting demonstration pilots - Promote the transfer of results at all levels through communication campaigns in social networks, videos on YouTube - Agreements between research and production entities to find innovative R&D solutions - Communication and transfer actions by field technicians (consultants) to disseminate solutions for the horticultural sector with a multidisciplinary approach
2. Quality certifications: - Promote quality certificates related to zero waste - Incorporating biodegradable materials in organic farming and integrated production
3. Subsidies and legislation: - Develop a regulatory framework that includes all types of inorganic waste in a differentiated manner, guaranteeing their correct management through a system of extended responsibility - Intensify or increase control of uncontrolled dumping - Use of public funding to clean up areas affected by spills - Promote administrative incentives and find out why the incentives that currently exist do not work properly - Include waste management fees in the operational programs of fruit and vegetable producer organizations
4. Waste managers, collection points: - Promote the existence of specific managers for each type of waste - Improve the network of easily accessible points (green points) where waste can be delivered at low cost and at short distances from production areas (e.g. more than one clean point in municipalities or large cities) - Promote appropriate separation of waste with reasonable appreciation
5. Various technical strategies: - Improving waste management logistics: e.g. promoting the use of waste compression machinery to avoid large storage volumes that can be processed by pyrolysis

Source: Own elaboration from the survey carried out within the framework of the REINWASTE project (2020).

1.4. CONCLUSIONS

The main conclusions of this study are set out below:

- The knowledge and concern of the horticultural production sector about the problems associated with waste is medium-high.

- The knowledge of the production sector about the alternatives tested in the REINWASTE project is more heterogeneous:

  - The raffias alternatives obtained a medium-high level of knowledge.
  - The energetic valorization options, as well as the associative management models, are slightly known by the sector (medium-low scores).
  - The knowledge of the physical document traceability system is very well known, as opposed to the document traceability system using software (low knowledge).

- The adoption potential of all the alternatives tested by REINWASTE is medium-high, so there is a high predisposition to implement innovative solutions in this sector that minimize or avoid the generation of waste.

- The adoption of innovation initiatives in the horticultural production sector has several limiting factors of considerable importance. The most important are the high costs and the lack of alternative materials to those used conventionally. In addition, the sector perceives that the alternative raffia and plastic mulch currently on the market do not offer the necessary technical characteristics. In this sense, and related to the two previous ones, the lack of research areas in the production areas is also perceived as a limiting factor for the adoption of innovation. Policies and the design of socioeconomic strategies must therefore be aimed at reducing, minimizing or eliminating this type of limiting factors.

- The main social, technical and economic factors promoting the adoption of innovation are:

  - The high social awareness of the problem of inorganic waste in the horticultural sector,
  - Significant improvements in terms of more environmentally friendly fencing elements and quilting plastics,
  - Associationism as a factor promoting innovation,
  - The willingness of producers to make technological and waste management improvements.

Therefore, strategies to promote the adoption of innovations in the horticultural sector should be based on such drivers as a starting point and a driving force to achieve a more environmentally,

socially and economically sustainable horticulture.

Taking into account the above-mentioned conclusions, some of the recommendations that can be put forward as strategies to build on the strengths of the horticultural sector while minimizing the limiting factors to the adoption of innovations are the following:

- Promote research and transfer of results of sustainable alternatives through different channels: field trials, workshops, videos in social networks, etc. and whenever possible in the productive areas.
- Create the figure of a specialist advisor to disseminate new knowledge generated around the alternatives available in horticulture, especially for raffia and mulching plastics.
- Promote quality certifications related to respect for the environment, specifically the reduction of inorganic waste.
- Promoting the existence of specific managers for each type of waste and improving the network of easily accessible collection points (green points) where waste can be delivered at an affordable cost in the immediate surroundings of the production areas.
- Developing a regulatory framework that includes all types of inorganic waste in a differentiated manner, guaranteeing their correct management through a system of extended responsibility.

2. POTENTIAL ADOPTION OF THE BEST INNOVATIVE SOLUTIONS IN THE HORTICULTURAL INDUSTRY

2.1. INTRODUCTION

The food sector faces the great challenge of feeding a world population that is expected to reach 10,000 million inhabitants by the middle of this century and promotes adaptation to sustainable production models, ensuring environmental balance, increasing biodiversity and continuity. of resources for future generations. Given its transversality, it is one of the few sectors that can positively impact the Sustainable Development Goals contemplated in the United Nations 2030 Agenda. Also, its contribution to biodiversity makes the agri-food chain a basic sector for the fight against climate change and the sustainability of the territory in the medium and long term. Key aspects such as water management, natural resource management, greenhouse gas emission mitigation, and adaptation or transition to a circular economy have been addressed by companies in the sector for some time.

In this transition towards a circular economy, we observe the European Strategy for Plastics: 2030 Goals. By 2030 all plastic packaging marketed in the EU must be reusable or can be recycled profitably. By 2030, more than half of the plastic waste generated in Europe will have to be recycled.

In line with these 2030 Goals, within the framework of the REINWASTE project, we work to help companies in the Andalusian fruit and vegetable sector to move towards ZERO packaging waste, and for this purpose, the packaging waste produced in the different processes and potential technological innovations are identified. could apply, as well as the best existing practices to minimize or eliminate the production of said waste.

The food industry is also a dynamic sector, where consumers have constantly evolving habits and demands. The consumer is no longer looking only for novel products, new flavors, but also for products to be sustainable. With the work carried out within the REINWASTE framework, the food industry adapts, innovates, and anticipates itself to respond to new consumer demands and trends.

In this context, within the framework of the REINWASTE project, different innovative solutions or Best Available Technologies or Practices have been identified to reduce and mitigate the problem and impact of inorganic waste generated in the horticulture sector; by analysing processes, identifying critical points, proposing implantable actions realistic in the short term, several pilot

actions have assessed the potential impact of the solutions.

2.2. METHODOLOGY

The information used to analyse the potential for adoption in the horticulture industry sector was obtained from a survey of experts in packaging materials and processes of food industry. The results of this study are therefore based on the 'expertise' and 'background' that the experts have on the sector and on the innovative solutions that potentially reduce or minimize waste, as well as on a review of their works related. The survey carried out, is structured in the following questions:

- The degree of concern and knowledge of producers/businesses about the problem of inorganic waste in general.

- The degree of knowledge of the innovative solutions available in the market to reduce inorganic waste in each step of the horticulture industry value chain.

- The level of knowledge of the five pilots proposed for the sector considered and their corresponding alternative solutions in the framework of the REINWASTE project.

- The potential for adoption of these tested pilots with alternative solutions for the horticulture industry sector.

- The limiting factors for the adoption of these alternatives (socio-economic, environmental, and technical) by the sector.

- The promoting factors that encourage and favour the adoption of these alternatives by the sector (socio-economic, environmental, and technical).

- The strategies that can be developed to promote and encourage the adoption of the alternative solutions tested with the pilots for the horticulture industry sector.

In order to quantify expert opinion on certain issues (importance, interest, level of agreement, etc.), the same scale has always been used, ranging from 1 (not important/not interesting, totally in disagreement, etc.) to 9 (very important, very interesting, very much in agreement, etc.). For the analysis of the data obtained, the information has been categorized as 'low' when the score is between 1 and 4, 'medium' when it is between 4 and 6 and 'high' for those scores over 6. Likewise, this work presents only a qualitative-descriptive analysis of the most important results of the different questions. The descriptive analysis is supported by arithmetic means and information generated by the surveys.

2.3. RESULTS

The following results are the description of the information obtained according to the opinion of

the experts interviewed for the horticulture industry sector. It should be emphasized that this information has been based on a scale from 1 to 9 as detailed in the methodology above.

III.1. Level of concern and knowledge of the inorganic waste generation in the horticulture sector as a problem and the alternatives in the market

With regard to the problem of inorganic waste generation in the global context and specifically in the horticulture industry sector, the results collected according to the degree of knowledge and concern of the sector are shown in Table 1.

Table 2.1. Level of concern and knowledge of the sector about the problem of inorganic waste and alternative market solutions

Topic	Average
Degree of general knowledge of the waste problem in the sector	**7**
Level of concern about the problem of inorganic waste generated in the sector	**6**
Degree of knowledge of alternatives available on the market to reduce inorganic waste	**6**

Source: Own elaboration from the survey carried out within the framework of the REINWASTE project (2020)

As it can be seen from the data collected through the survey, the knowledge of the existing problem in the horticulture sector is high (average 7) while the concern about the generation of waste is medium (average 6) also the sector's knowledge of the alternative solutions in the market to minimize, reduce or eliminate inorganic waste is medium (average 6).

Therefore, it seems there is still "room" for increasing the awareness and knowledge of the sector about the problem of waste and the range of sustainable alternatives available in the market.

III.2. Level of knowledge of the alternatives tested in the REINWASTE project pilots of the horticulture industry sector

The results presented in this section are related to the direct knowledge that the horticulture

industry sector shown about the alternatives tested in each of the pilots identified and carried out within the framework of the REINWASTE project. The results are summarised in Table 2.2.

Table 2.2. Knowledge of the alternatives tested in the REINWASTE pilots

	Low			Medium			High		
Degree of knowledge of innovative alternatives	1	2	3	4	5	6	7	8	9
1. Alternatives to the conventional use of plastic trays									
• 85-100% rPET: incorporate recycled material (recycled PET) in the packaging while putting into the market a 100% recyclable PET packaging							x		
• 100% biodegradable packaging by using biodegradable plastics such as PLA						x			
• Carton tray								x	
2. Logistics optimization									
• Change dimensions of the packaging (primary packaging)						x			
• Rethink the whole packaging so it results in a more sustainable packaging tray that fits into a secondary packaging that should be adapted to the new way						x			
3. Rethinking packaging									

• Compostable plastic flowpack to have a whole biodegradable packaging solution					x				
• Cardboard tray with lid, to get rid of the plastic flowpack						x			
• Bands to substitute the whole package so an almost zero waste solution is achieved							x		

Source: Own elaboration from the survey carried out within the framework of the REINWASTE project (2020).

Concerning the knowledge that the sector has about the alternative solutions the most known are the use of rPET: incorporate recycled material (recycled PET) in the packaging while putting into the market a 100% recyclable PET packaging (average 7), the use of cardboard (average 8), as well as the use of bands to substitute the whole package so an almost zero waste solution is achieved (average 7). Other innovative alternatives related to logistics optimization are medium known, the change in dimensions of the cardboard box or to rethink the whole packaging resulting in a more sustainable packaging tray (average 6), so important to consider the eco-design tools to reduce inorganic waste in the sector.

III.3. Potential for adoption of the alternatives tested in REINWASTE

Through this question, the potential for adoption by the horticulture industrial sector is evaluated through expert knowledge based on the different alternatives tested in the REINWASTE project and commented in the previous section. The results are presented in Table 2.3.

Table 2.3. Potential adoption of the alternatives tested in the REINWASTE pilots

	Low			Medium			High		
Degree of potential adoption of the following innovative alternatives	1	2	3	4	5	6	7	8	9
1. Alternatives to the conventional use of plastic trays									
1. 85-100% rPET: incorporate recycled material (recycled PET) in the packaging while putting into the market a 100% recyclable PET packaging								x	

	Low			Medium			High		
Degree of potential adoption of the following innovative alternatives	1	2	3	4	5	6	7	8	9
2. 100% biodegradable packaging by using biodegradable plastics such as PLA						x			
3. Carton tray								x	
2. Logistics optimization									
1. Change dimensions of the packaging								x	
2. Rethink the whole packaging so it results in a more sustainable packaging tray that fits into a secondary packaging that should be adapted to the new way								x	
3. Rethinking packaging									
1. Compostable plastic flowpack to have a whole biodegradable packaging solution					x				
2. Cardboard tray with lid, to get rid of the plastic flowpack							x		
3. Bands to substitute the whole package so an almost zero waste solution is achieved								x	

Source: Own elaboration from the survey carried out within the framework of the REINWASTE project (2020).

In the potential for adoption that the sector has with respect to the available alternatives, the use of rPET: incorporate recycled material (recycled PET) in the packaging while putting into the market a 100% recyclable PET packaging, the use of carboard trays and bands to substitute the whole packaging showed a very good potential for adoption (average 8). These solutions have

been tested by the horticulture companies. Horticulture industry companies are already adopting the above-mentioned solutions including investment in technology to avoid packaging and implementing machinery to use bands as packaging.

III.4. Limiting factors for the adoption of innovations in the horticulture industry sector

In the following table, different factors that limit adoption of alternatives proposed to reduce inorganic waste in horticulture sector are considered, following methodology of the experts surveys.

Table 2.4. Limiting factors in the adoption of the alternatives for the reduction of inorganic waste

Limiting factors	Average
Lack of knowledge from the supplier of the “new materials”	**5**
Low degree of technical update from the people involved in the Quality/Materials Dept.	**6**
Continuous changes of the regulatory framework (plastic taxes, etc.)	**7**
Assessment of food safety standards on food contact materials	**7**
Investment and funds	**7,5**

Source: Own elaboration from the survey carried out within the framework of the REINWASTE project (2020).

Experts considered that aspects related to necessary investment (average of 7,5) and the food safety assessments are limiting factors. Thus, both factors represent, still, a real barrier to the effective introduction of innovation regarding the use of “biobased materials” (i.e., bioplastics and compostable materials) which could highly contribute to improve the circularity and to reduce the generation of the packaging waste volumes at plant level. Another stage of limitations, on the same level, is represented by the variations occurred to the regulatory framework the less-retained limiting factors are represented by the lack of knowledge from the suppliers of “new materials” and the low degree of technical update from the people involved in the Quality dept.

III.5. Promoting factors for the adoption of innovation in the horticulture industry sector

The results obtained in relation to the factors that promote the adoption of the alternative measures for a better management of inorganic waste are shown below (Table 2.5).

Table 2.5. Promoting factors in the adoption of the alternatives for the reduction of inorganic

Promoting factors	Average
Marketing leverage	**8**
Consumer acceptance in terms of impact on sustainability	**9**
Improvement of CSR company strategy	**7**
Reduction of packaging waste volumes	**7**
Others (please indicate):	

Source: Own elaboration from the survey carried out within the framework of the REINWASTE project (2020).

Respecting to the factors that promote the adoption of innovation, the horticulture sector fees that the most important one is the consumer acceptance in terms of impact on sustainability, which received an average of 9. It is quite normal because at company level, when introducing an innovation, the perception of any changes by the consumers is considered largely relevant.

Other factors which are perceived rather important are both the marketing leverage (8) and the improvement of the company Corporate Social Responsibility (CSR) strategy (average 7) and they are clearly connected to the consumer acceptance topic. The food companies (not only horticulture) are very keen about how to valorise their engagement on the sustainability topic.

III.6. Strategies to encourage the adoption of tested alternatives in the horticulture industry sector to reduce and/or minimize the generation of inorganic waste

According to the knowledge and feedback collected by the experts who participated in this short survey, the following strategies are recommended for the horticulture industry sector in order to promote the adoption of the alternatives tested within the framework of the REINWASTE project:

- Better involvement of plastic producers/processors and suppliers of packaging
- Extensive dialogue with regional / national waste treatment facilities operators
- Better use of funding schemes existing at national/regional to finance the necessary investments at plant level

2.4. CONCLUSIONS

During the testing activities carried out in the horticulture industry companies it was clear that the packaging waste topic was considered an issue.

Thus, it was difficult to quantify amounts of waste because its management is usually subcontracted and the company pays a fixed cost for the service, irrespective of the amounts.

With respect to the measures proposed, all of them could bring benefits in terms of sustainability of the food chain. In particular:

- Use of rPET
- Investment in machinery to replace plastic packaging by bands
- Eco design in primary and secondary packaging

However, any change in packaging systems needs feasibility assessment to assure food safety. Innovative sustainable materials are available, the cost is expected to decrease in the next few years.

Plastic should continue to be used, though in a wiser manner (i.e., optimisation of packaging materials in view of the best end-of-life and eco-design. R-PET represents an opportunity for plastic waste reduction since it allows perfect circularity of plastic (return to the same use).

MEAT PRODUCTION IS MISSING

3. POTENTIAL ADOPTION OF THE BEST INNOVATIVE SOLUTIONS IN THE MEAT INDUSTRY

3.1. INTRODUCTION

The information used to analyze the potential for adoption in the meat production sector was obtained from a survey of five experts of the meat sector. These experts were chosen of the following profiles: 1 food technique expert, two technicians from the sector and two managers. The surveys were carried out from April to June 2020. The results of this study are therefore based on the 'expertise' and 'background' that the experts have on the meat sector and on the innovative solutions that potentially reduce or minimize waste, as well as on a review of diverse literature such as articles, reports, etc. on the subject.

In order to quantify expert opinion on certain issues (importance, interest, level of agreement, etc.), the same scale has always been used, ranging from 1 (not important/not interesting, totally in disagreement, etc.) to 9 (very important, very interesting, very much in agreement, etc.). For the analysis of the data obtained, the information has been categorized as 'low' when the score is between 1 and 4, 'medium' when it is between 4 and 6 and 'high' for those scores over 6.

3.2. METHODOLOGY

Five companies have tested 1, 2 or 3 different pilots, inducing a final number of tested pilots of 7 instead of the 5 needed initially. Pilots considered in this analyze implemented by CRITT and ANIA, and their alternatives, are the following (See annex I):

- Slice Product packaging:
  - No Skelton technology
  - Sealing mono PP trays under skin
  - Avoid adding dark pigment (suppression of the carbon black)
- Whole ham packaging:

- Use waste as energetic valorization, complex material valorization or demand from suppliers the use of recycled or bio sourced (PE) materials
- A single packaging in a " meat adhesion" film
- A single packaging in valve film
- Coupling with High Pressure treatment of packaged ham

- Thermoforming trays:
  - Thermoforming of trays in mono APET instead of PVC-PE
  - Thermoforming of trays in mono PET instead of PVC-PE
- Sealing lines:
  - Technology under skin
- Doypak Packaging:
  - Removal of caps and beak
  - Removal of aluminum layer
- Packaging of precooked ready-cooked meals:
  - Replacement of a PET-PE hull by a mono PP hull
- Single use cutlery in on the go dishes:
  - Removal of single use cutlery
  - Replacement of plastic cutlery by wood or comestible cutlery
  - Replacement of single use cutlery by reusable cutlery
  - Redesigning the function of cutlery

3.3. RESULTS

The following results are the description of the information obtained according to the opinion of the experts interviewed for the meat production sector. It should be emphasized that this information has been based on a scale from 1 to 9 as detailed in the methodology above and is an average of the fifth expert answers.

III.1 Level of concern and knowledge of the inorganic waste generation in meat production sector as a problem and the alternatives in the market

Table 3. 1: Level of concern and knowledge of the sector about the problem of inorganic waste and alternative market solutions

Level of concern and knowledge	Average
Degree of concern of the waste problematic in the sector	6,2
Degree of general knowledge of the waste problematic in the sector	4,2

Degree of knowledge of the potential innovative solutions available in the market to reduce inorganic waste	3,6

According to Table 3.1, the degree of concerned of waste problematic in the meat sector is high (average 6.2), the degree of general knowledge of the waste problematic in the meat sector is medium (4.2) and the degree of knowledge of the potential innovative solutions available in the market is low (3.6).

III.2 Level of knowledge of the alternatives tested in the REINWASTE project pilots of meat production sector

Table 3.2: Degree of knowledge of innovative alternatives

Degree of knowledge of the following innovative alternatives	Average
1. Slice Product packaging	
1.1. No Skelton technology	4,6
1.2. Sealing mono PP trays under skin	4,6
1.3. Avoid adding dark pigment (suppression of the carbon black)	5,4
2. Whole ham packaging	
2.1. Use waste as energetic valorization, complex material valorization or demand from suppliers the use of recycled or bio sourced (PE) materials	4,6
2.2. A single packaging in a " meat adhesion" film	3,8
2.3. A single packaging in valve film	3,2
2.4. Coupling with High Pressure treatment of packaged ham	2,8
3. Thermoforming trays	
3.1. Thermoforming of trays in mono APET instead of PVC-PE	4,6
3.2. Thermoforming of trays in mono PET instead of PVC-PE	5,8
4. Sealing lines	
4.1. Technology under skin	4,2
5. Doypak Packaging	
5.1. Removal of caps and beak	6,6

5.2. Removal of aluminum layer	5,4
6. Packaging of precooked ready-cooked meals	
6.1. Replacement of a PET-PE hull by a mono PP hull	5,4
7. Single use cutlery in on the go dishes	
7.1. Removal of single use cutlery	8
7.2. Replacement of plastic cutlery by wood or comestible cutlery	8,6
7.3. Replacement of single use cutlery by reusable cutlery	8,2
7.4. Redesigning the function of cutlery	5,6

Regarding results on Table 3.2, the degrees of knowledge of single use cutlery alternative solutions are the highest (from 8,0 to 8,6), except for the redesigning function solution (average of 5,6). They are the most common practices known. In the contrary, the lowest degrees of knowledge are in innovative packaging for whole ham (average between 2,8 to 4,6), especially for the alternative of possibility of using High Pressure Treatment (lowest average of 2,8). They are the less know practices. In the middle of these two pilots, the fifth other pilots shows medium values, with averages between 4,2 to 6,6.

III.3 Potential for adoption of the alternatives tested in REINWASTE

Table3.3: Degree of potential for adoption of the alternatives tested in REINWASTE

Degree of knowledge of the following innovative alternatives	Average
1. Sliced product packaging	
1.1. No Skelton technology	4,4
1.2. Sealing mono PP trays under skin	4,6
1.3. Avoid adding dark pigment (suppression of the carbon black)	6
2. Whole ham packaging	
2.1. Use waste as energetic valorization, complex material valorization or demand from suppliers the use of recycled or bio sourced (PE) materials	5
2.2. A single packaging in a " meat adhesion" film	4,6
2.3. A single packaging in valve film	3,8

Degree of knowledge of the following innovative alternatives	Average
2.4. Coupling with High Pressure treatment of packaged ham	3
3. Thermoforming trays	
3.1. Thermoforming of trays in mono APET instead of PVC-PE	5,2
3.2. Thermoforming of trays in mono PET instead of PVC-PE	5,2
4. Sealing lines	
4.1. Technology under skin	3,6
5. Doypak Packaging	
5.1. Removal of caps and beak	6,6
5.2. Removal of aluminum layer	5,4
6. Packaging of precooked ready-cooked meals	
6.1. Replacement of a PET-PE hull by a mono PP hull	4,6
7. Single use cutlery in on the go dishes	
7.1. Removal of single use cutlery	7,6
7.2. Replacement of plastics cutlery by wood or comestible cutlery	8,2
7.3. Replacement of single use cutlery by reusable cutlery	7,6
7.4. Redesigning the function of cutlery	5,6

As for degree of potential for adoption of the alternatives tested in REINWASTE, the results show the same pattern than for the degree of knowledge of the alternatives innovation. The highest degrees of potential adaptation are for single use cutlery solutions with averages from 7,6 to 8,2 and an exception for the redesigning the function of cutlery that has an average of 5.6. The lowest degrees of adaptation are for alternatives for whole ham packaging with averages between 3,0 to 5,0. These are the innovative solutions that have the lowest potential of adoption. It is also important to notice that the pilot "sealing lines", with the alternative solution using a technology under skin has also a low average value (3,6). The other 4 pilots, have medium average values, between 4,4 to 6,6.

III.4 Limiting factors for the adoption of innovations in the producing meat sector

Table 3.4: Limiting factors for the adoption of innovations in the producing meat sector

Limiting factors	Average
Cost of alternative materials	8,4
Materials availability	6,6
Sanitary risks: sealing of packaging	7,8
Sanitary risks: food contact aptitude	8
Barrier properties: reduced service life	8
Reduction of mechanical resistance	6,4
Reduction of temperature resistance	7,6
Incompatibility with microwave cooking/heating	7,8

According to Table 3.4, the top 3 most limiting factors for the adoption of innovations in the producing meat sector are the cost of the alternative materials (8,4), the sanitary risks regarding the food contact aptitude of the material (8,0) and, the barrier properties that could induce a reduction of the service life (8,0). The lowest limiting factor is the reduction of mechanical resistance, with an average of 6,4. Also, it is important to notice that, all the others limiting factors have an average degree above six, so that it is considered high.

In order to overcome these limiting factors, strategies should be developed. The strategies can be built regarding the promoting factors that have been found, and explained in paragraph III.5, below.

III.5 Promoting factors for the adoption of innovation in the meat production sector

Table 3.5: Promoting factors for the adoption of innovation in the meat production sector

Promoting factors	Average
Cost reduction	8,8
Respect of law	8,4
Improvement of company image	6,6
Company commitment in RSE	5,4

Image of a more virtuous product	7
Consumer awareness	8,2

Regarding Table 3.5, the top 3 promoting factors for the adoption of innovation are the cost reduction that could induce a change (8,8), but as seen previously, a change can also induce an increase of costs for companies. So, this cost of adoption of an alternative method should be well considered, in short and long term, to determine if it would be an increase or a decrease for the company. Then, the respect of law (average 8,4) and the awareness of consumers (8,2) are also important promoting factors. The others are all above 6, except for the company commitment that is medium, with 5,4.

III.6 Strategies to encourage the adoption of tested alternatives in the producing meat sector to reduce and/or minimize the generation of inorganic waste

Table 3.6: Strategy to promote the adoption of the tested pilot alternatives

1. Political recommendation: encourage companies to adopt alternative solutions thanks to regional and national technical et financial supports
2. Encourage research and development project about new alternative solutions
3. Regional support for companies who are willing to put alternative solutions in place
4. Raising awareness of consumers

Four strategies to promote the adoption of the tested pilot alternatives have been proposed by the experts. Support for companies that would encourage them to adopt alternative solutions, at a regional or at a national level. Also, encourage research and development on this topic and the raising awareness of consumers.

3.4. CONCLUSIONS

The main conclusions of this study are set out below:

- The knowledge and concern of the meat production sector about the problems associated with waste is medium-high.
- The knowledge of the production sector about the alternatives tested in the REINWASTE project is more heterogeneous:
  - The packaging of sliced product and precooked ready-cooked meals, as well as the thermoforming trays and the sealing lines, obtained a medium level of knowledge.
  - The whole ham packaging alternatives are slightly known by the sector (medium-low scores).
  - The knowledge of the doypak packaging and the single use cutlery in on the go dishes are quite well known.

- The adoption potential of all the alternatives tested by REINWASTE is also heterogeneous:
  - The packaging of sliced product and precooked ready-cooked meals, as well as the thermoforming trays, obtained a medium predisposition degree to implement innovative solutions in this sector.
  - The whole ham packaging alternatives as well as the sealing lines show slightly predisposition degree to implement innovative solutions in this sector. (medium-low scores).

- The knowledge of the doypak packaging and the single use cutlery in on the go dishes have high/medium predisposition to implement innovative solutions in this sector.

- The adoption of innovation initiatives in the meat production sector has several limiting factors of considerable importance. The most important are the high costs, the sanitary risks concerning the food contact aptitude, and the barrier properties. In addition, the sector perceives that the alternative material for packaging can induce a sanitary risk for the sealing. Policies and the design of socioeconomic strategies must therefore be aimed at reducing, minimizing or eliminating this type of limiting factors.

- The main social, technical and economic factors promoting the adoption of innovation are:
  - The cost reduction that induce an alternative solutions
  - The respect of low in terms of environmental aspect, the improvement of the company image, the company commitment in RSE
  - The consumer awareness that is rising, the image of a more virtuous product

Therefore, strategies to promote the adoption of innovations in the meat sector should be based on such drivers as a starting point and a driving force to achieve a more environmentally socially and economically sustainable meat industry. Taking into account the above-mentioned conclusions, some of the recommendations that can be put forward as strategies to build on the strengths of the meat sector while minimizing the limiting factors to the adoption of innovations are the following:

- Political recommendation: encourage companies to adopt alternative solutions thanks to regional and national technical et financial supports
- Encourage research and development project about new alternative solutions
- Regional support for companies who are willing to put alternative solutions in place
- Raising awareness of consumers.

4. POTENTIAL ADOPTION OF THE BEST INNOVATIVE SOLUTIONS IN THE DAIRY PRODUCTION

4.1. INTRODUCTION

Innovation is a keyword linked to change which means progress, improvement of the existing situation, advancement, development. Even in the agricultural field, innovation is strongly linked not only to the development of the primary sector but becomes a determining factor for the development of rural areas. The starting point is the definition of the concept, which is not always so clear. The goal, on the other hand, should be to improve the competitiveness, efficient management of resources and the environmental performance of supply chains and rural economic systems. In other words, the knowledge and innovation system become strategic development levers for agriculture and rural systems. In general, but above all in agriculture, one of the main effects of the introduction of innovations in companies and territorial systems is the growth of productivity and competitiveness which is a very synthetic expression to indicate all the different ways in which such growth can take place: from the better allocation of production factors to the diversification of production, from the qualitative improvement of food products to the development of products that can be used for other uses, from the reduction of the indirect costs of environmental pollution to the overcoming of the context difficulties created by some specific pedoclimatic conditions (drought , erosion, salinity, etc.). Of course, not all operational areas in which innovation can be used are replicable in any context and above all, given a certain condition, not all innovations can generate increased productivity and competitiveness. Therefore, one of the first fixed points when it comes to innovation in agriculture is the awareness of facing a winning theme, but only to the extent that an approach is adopted that can consider its complexity.

"Innovation is also described as a new idea that finds success in practice. The new idea can be a new product, practice, service, production process and a new way of organizing things etc. (EC, Draft on EIP 06/2013)". In this context, all the results of the experiment conducted by Confagricoltura within the Reinwaste project should be read. In fact, alongside the solutions identified to reduce the main inorganic waste, general recommendations were provided regarding "small innovations", already available on the market, which can become small "revolutions" if they

were applied throughout the agricultural sector (larger containers for detergents with the possibility of refill the containers, eco-design solutions, etc). This makes more sense when we consider that agriculture waste is produced in reduced quantities compared to other sectors and areas.

Furthermore, it is necessary to consider the photography of dairy sector Emilia Romagna: there are about 3500 dairy cattle farms in Emilia- Romagna Region compared to 26,000 dairy cattle farms in Italy (with an incidence of 13%); 2 million tons of milk produced in Emilia Romagna respect the total national production 12 million tons (about 16%). It also follows that, due to the type of production (milk) and the Region in which the trial was conducted (Emilia Romagna), which allocates 90% of milk production in Parmigiano Reggiano that which does not require packaging in its transport, the management of inorganic waste has not yet represented a problem for farmers and waste plant managers.

As for the solutions identified to reduce the main inorganic waste in the dairy sector in Emilia Romagna (nets for round bales and silage films), which will be described and analyzed below, it should be noted that the Reinwaste test highlighted that there is a need to have a diversification of the applicable solutions for reducing the use of plastics and inorganic materials in the primary dairy sector, given the differences in size, level of innovation and production system aimed at obtaining of a product often linked to different production regulations with respect to the DOP circuit.

4.2.METHODOLOGY

The information used to analyze the potential for adoption in the dairy agricultural sector was obtained from a survey of five experts. Their profile is: 1 researcher, 1 expert in organic farming, 1 fodder producer, 1 farmer and 1 expert from the Reinwaste project.

The surveys were carried out during the first half of November 2020.

The results of this study are therefore based on the 'expertise' and 'background' that the experts have on the sector and on the innovative solutions that potentially reduce or minimize waste. The survey carried out, is structured in the following blocks:

1) The degree of concern and knowledge of producers/businesses about the problem of inorganic waste in general.
2) The level of knowledge of the innovative solutions proposed for the sector considered and their corresponding alternative solutions in the framework of the REINWASTE project.
3) The potential for adoption of these tested alternative solutions for the dairy agricultural sector.

4) The limiting factors for the adoption of these alternatives (socioeconomic, environmental, and technical) by the sector.

5) The promoting factors that encourage the adoption of these alternatives by the sector (socio-economic, environmental, and technical).

The strategies that can be developed to promote and encourage the adoption of the alternative solutions tested with the pilots for the dairy sector.

To quantify expert opinion on certain issues (importance, interest, level of agreement, etc.), the same scale has always been used, ranging from 1 (not important/not interesting, totally in disagreement, etc.) to 9 (very important, very interesting, very much in agreement, etc.).

For the analysis of the data obtained, the information has been categorized as 'low' when the score is between 1 and 4, 'medium' when it is between 4 and 6 and 'high' for those scores over 6.

The tested pilots and their correspondent studied alternatives are shown in Annex 2 for more detail. Likewise, this work presents only a qualitative-descriptive analysis of the most important results of the different blocks. The most important aspects of univariate and descriptive analysis are presented here in the form of means the information generated by the surveys.

4.3.RESULTS

The following results are the description of the information obtained according to the opinion of the experts interviewed for the dairy production sector. It should be emphasized that this information has been based on a scale from 1 to 9 as detailed in the methodology above.

III.1. Level of concern and knowledge of the inorganic waste generation in the dairy sector as a problem and the alternatives in the market

About the problem of inorganic waste generation in the global context and specifically in the dairy industry sector, the results collected according to the degree of knowledge and concern of the sector are shown in Table 1.

Table 4.1. Level of concern and knowledge of the sector about the problem of inorganic waste and alternative market solutions

Topic	Average
Degree of **concern** of the waste problematic in the sector	6.2
Degree of general **knowledge** of the waste problematic in the sector	6.6
Degree of **knowledge of the potential innovative solutions**	6

available in the market to reduce inorganic waste	

Source: Own elaboration from the survey carried out within the framework of the REINWASTE project (2020)

It should also be considered that all were given high ratings (7 or 8), except in one case in which a low level of knowledge was attributed. This obviously affected the media. As it can be seen from the data collected through the survey, the concern of the existing problem in the dairy sector is at medium level (average 6,2) as well as the knowledge about the generation of waste (average 6.6) and, at the same way, also the sector's knowledge of the alternative solutions in the market to minimize, reduce or eliminate inorganic waste is medium (average 6).

III.2. Level of knowledge of the alternatives tested in the REINWASTE project pilots of the dairy production sector

The results presented in this section are related to the direct knowledge that the dairy production sector shown about the alternatives tested in each of the pilots identified and carried out within the framework of the REINWASTE project.

The results are summarised in Table 4.2.

Table 4.2 Level of knowledge of the alternatives tested in the REINWASTE project pilots of the dairy production sector

PILOT 1: REDUCTION OF ROUND BALE NETS	**Average**
Alternative 1.Use of round bale net with a 5 % lower weight	6.2
Alternative 2. Polypropylene twine	5.8
Alternative 3. SISAL twine	5.4
Alternative 4. Use of the Big Baler	6.8
Alternative 5. Use of the two-stage haymaking process of loose hay	7
PILOT2 :REDUCTION OF PLASTIC SILAGE FILM BECAME WASTE	
Alternative 1. Use silage film of less thickness	6.6
Alternative 2. Use of haylage round bales	6.4

Source: Own elaboration from the survey carried out within the framework of the REINWASTE project (2020).

With regard to the knowledge that the sector has about the alternative solutions, the table shows that for pilot1 the big baler use (media 6.8) and the two-stage haymaking process of loose hay (media 7), are the best known alternatives than round bale net with a 5% lower weight (average 6.2), Polypropylene twine (5.8), SISAL twine (average 5.4).

While for pilot 2, the knowledge that the sector has about the alternative solutions is almost the same, settling around the average level of 6.6 and 6.4, respectively.

Consequently, more emphasis should be placed on disseminating knowledge about the first solution for pilot 1 that which appears to have the best environmental performance.

III.3. Potential for adoption of the alternatives tested in REINWASTE

Through this question, the potential for adoption by the dairy production sector is evaluated through expert knowledge based on the different alternatives tested in the REINWASTE project and commented in the previous section. The results are presented in Table 4.3.

Table .4.3. Potential adoption of the alternatives tested in the REINWASTE

PILOT 1: REDUCTION OF ROUND BALE NETS	**Average**
Alternative 1.Use of round bale net with a 5 % lower weight	6.2
Alternative 2. Polypropylene twine	5
Alternative 3. SISAL twine	5.2
Alternative 4. Use of the Big Baler	4.6
Alternative 5. Use of the two-stage haymaking process of loose hay	5
PILOT 2. REDUCTION OF PLASTIC SILAGE FILM BECAME WASTE	
Alternative 1. Use silage film of less thickness	5.6
Alternative 2. Use of haylage round bales	5.6

Source: Own elaboration from the survey carried out within the framework of the REINWASTE project (2020).

In the potential for adoption that the sector has with respect to the available alternatives showed a medium/low interest on it for both the pilots (average max 6.2, minimum 4.6). The reason for this is related to the fact that as highlighted in the Reinwaste test phase. The research carried out, in fact, has shown that for the dairy sector there are no innovations that make it possible to replace plastic materials with biodegradable materials or the few research and experiments carried out, such as those on plastic silage covering films, do not yet have a mature technology for be applicable to such use. There is no European technical standard on the biodegradability characteristics of silage covering plastic films or round bales nets. In addition, a substantial difficulty has emerged in significantly reducing the use of plastics at least with the technologies currently available as alternative materials are not available now with the same performance.

There are also difficulties to recycle the waste from round bales nets or plastic covering films for silage, due to the residual material (e.g., hay, straw, earth) which does not allow recycling due to the difficulties in cleaning the waste.

From this emerges the need of promote research on the use of biodegradable materials or, at least, greater innovation in eco-design to reduce the use of plastic materials or to facilitate the removal of residual material to allow for recycling and to assess the need to strengthen the infrastructures for the recycling of materials present in the area.

III.4. Limiting factors for the adoption of innovations in the dairy primary sector

Table 4.4. Limiting factors in the adoption of the alternatives for the reduction of inorganic waste

Limiting factors	**Average**
the alternatives cannot be considered universally valid for all farms in the livestock sector	6.8
The impact of the solution available	5.6
The waste management now it is not perceived as a problem	5

Source: Own elaboration from the survey carried out within the framework of the REINWASTE project(2020).

Experts considered that the most limiting factor is related to the fact of the alternatives cannot be considered universally valid for all farms in the livestock sector (average of 6.8).

In addition, the limited impact of the solutions currently available is quite significant (average 5.6). Finally, the lack of knowledge of waste management is considered a limiting factor with less impact.

This insight offered by the experts confirms what emerged during the Reinwaste experimentation regarding the need to strengthen research in identifying solutions for the reduction of plastics in the dairy sector that are applicable to companies with different characteristics and that can have a significant impact in management of non-organic waste.

PROMOTING FACTORS ARE MISSING

III.5. Strategies to encourage the adoption of tested alternatives in the dairy production sector to reduce and/or minimize the generation of inorganic waste

According to the knowledge and feedback collected by the experts who participated in this short survey, the following strategies are recommended for the dairy primary sector in order to promote the adoption of the alternatives tested within the framework of the REINWASTE project:

- About Incentives one expert suggested that one can introduce some priorities for access to the PSR measure, or specific allowances for the purchase of machinery and equipment to reduce waste. One could focus on a possible cost reduction or increase earnings.
- About information issue two expert suggested to organize a “innovation day” to improve communication between the agricultural company and the companies that manage agricultural waste, to identify good practices that will improve the management of temporary storage on the farm, increasing the amount of waste to be used for recovery operations and show in detail all the innovations in this field. The information should concentrate to increase accountability towards environmental issues. Notwithstanding that a reduce the waste in many cases, can represent an increase in expenses. It is important understand why to buy new machinery and/or equipment or to modify his productive technique to reduce plastic waste.

4.4. CONCLUSIONS

The plurality, diversity and the quantity of the stakeholders involved leads to non-homogeneous answers considering the different point of view of the stakeholders involved. Regarding the analysis of the answers some considerations can be drawn:

- The level of concern about the problem of waste, knowledge of the problem of waste and of the potential innovative solutions available on the market to reduce inorganic waste, tends to be medium-high level.

- The knowledge of the alternatives currently available to the use of traditional nets for round plastic bales nets is generally medium-high, as well as the alternatives to the use of traditional plastic films for silage.

- The potential of adoption that the sector has with respect to the available alternatives showed a medium/low interest for both pilots (average max 6.2, minimum 4.6). The reason is the lack of innovation on this topic so there is the need of promote research on the use of biodegradable materials or, at least, greater innovation in eco-design to reduce the use of plastic materials or to facilitate the removal of residual material to allow for recycling and to assess the need to strengthen the infrastructures for the recycling of materials present in the area.

- With reference to the factors limiting the adoption of alternatives, experts considered that the most limiting factor is related to the fact of the alternatives cannot be considered universally valid for all farms in the livestock sector (average of 6.8). This insight offered by the experts confirms what emerged during the Reinwaste experimentation regarding the need to strengthen research in identifying solutions for the reduction of plastics in the dairy sector that are applicable to companies with different characteristics and that can have a significant impact in management of non-organic waste.

- Finally, there is a positive assessment of the need for incentives and information. Some stakeholders also provided specific consideration about incentive and information activities.

5. POTENTIAL ADOPTION OF THE BEST INNOVATIVE SOLUTIONS IN THE DAIRY INDUSTRY

5.1. INTRODUCTION

Emilia-Romagna region (ER) is a leader in Europe with regards for agriculture, farming and food industry related activities. As for the dairy industrial sector, ER is the region with the largest number of companies (381 units) mainly devoted to the production of Parmigiano Reggiano cheese.

In this region approximately half of the total 23 dairy cooperatives existing in Italy are operating. This corporate form (characterized by small and very small companies) represents about 63% of the total of local units in Emilia-Romagna.

The sector is highly fragmented: 381 operators produce 148 thousand tons. With a focus on cheese production 80% of production is made up of hard cheeses, followed by the 17% of fresh cheeses while semi-hard and soft cheeses are very low.

The agrifood sector is included in the first strategic priority of the Research and Innovation Strategy for Smart Specialisation (S3), as one of the pillars of the regional economy, representing 16.7% of the regional employees and contributing significantly to the overall export. It starts from an already advanced level, but there are significant margins for improvement which are all relevant for Reinwaste objectives.

Investment in research has to bring benefits for society through increased knowledge, new products and services having better attributes, new jobs and contribution to the competitiveness of the companies. In Europe efforts in public research have been focused mostly on creating new knowledge and disseminating it through scientific publications; less attention has been paid to the conversion of the scientific results into solutions, which can be used by industry. Mainly the public benefits of increasing knowledge through scientific excellence have been emphasized, particularly with publicly funded research projects. In the USA and some other leading economies outside Europe, the commercialisation aspects of research results are taken as equally important as

dissemination for the scientific community. For effective exploitation of the new knowledge in the public sector, it is necessary to identify and protect those elements of the results, which can form an intellectual property, which can be protected. Industrial users usually expect confidentiality and at least a certain level of exclusivity of the specific knowledge, in which they invest money, efforts and other resources, which ensures them competitive advantage. It has been recognised that one of main constraints of the competitiveness of the European economy is the weakness of the transfer of knowledge from researchers to the private sector for exploitation.

Several research results and practical experiences show that one of the main barriers in effective knowledge transfer is the difference in the way of thinking and priorities of industry and researchers. There are significant differences also between the approach and the opportunities of large companies and SMEs. While researchers usually focus on scientific excellence expressed in validated statements and methods, based on substantial proofs and think over a longer time period, SMEs need a solution for a problem, which can be implemented easily – in many cases with limited resources – and quickly.

Identifying needs and exploring hidden needs of industry

Careful preparation by knowledge transfer personnel is essential before discussions with companies, particularly with SMEs on their research needs. The preparation should typically cover collecting information on the activity of the company, establishing good overview of the typical problems and avoidable R+D results and practical solutions in the potential area of interest of the company and on the current typical challenges for the industry sector.

The interest of the representative of the company has to be raised at an early phase of the discussion. The message to support this should be explained in a clear, concise, easily understandable way, focusing on the benefits to the company of using the knowledge-based solutions offered. Details can follow once the interest has already been established.

For exploring the needs of the company, dialogue should be encouraged. Careful listening is recommended to the explanations of the company representative about their problems, needs, ideas. SMEs they first have to be made aware on the available solutions. Presentation of successful examples can be motivating for SMEs.

Adoption comprises two key aspects: risk in choice and knowledge acquisition. The risk involved in the process of adopting innovation decreases as the farmer's knowledge increases. The decision, therefore, will depend on the knowledge of the different conditioning parameters that the producer has and, therefore, strategies based on these factors could favor the adoption of the innovation.

In this context, within the framework of the REINWASTE project, different innovative solutions (also called BATs, Best Available Technologies) have been identified to reduce and mitigate the problem and impact of inorganic waste generated in three agri-food value chains (dairy in Italy;

horticulture in Spain; meat in France). Among these, several pilot actions have assessed the potential impact of the solutions in the dairy industry.

5.2. METHODOLOGY

The information used to analyse the potential for adoption in the dairy industry sector was obtained from a survey of five experts. Their profile were: one from food industry, three from R&D and one from a private agency dealing with packaging materials. The surveys were carried out during the first half of November 2020. The results of this study are therefore based on the 'expertise' and 'background' that the experts have on the sector and on the innovative solutions that potentially reduce or minimize waste, as well as on a review of diverse literature such as articles, reports, etc. on the subject. The survey carried out, is structured in the following blocks (see Annex 1 for more detail):

- The degree of concern and knowledge of producers/businesses about the problem of inorganic waste in general.

- The degree of knowledge of the innovative solutions available in the market to reduce inorganic waste in each step of the dairy industry value chain.

- The level of knowledge of the five pilots proposed for the sector considered and their corresponding alternative solutions in the framework of the REINWASTE project.

- The potential for adoption of these tested pilots with alternative solutions for the dairy industry sector.

- The limiting factors for the adoption of these alternatives (socio-economic, environmental and technical) by the sector.

- The promoting factors that encourage and favor the adoption of these alternatives by the sector (socio-economic, environmental and technical).

- The strategies that can be developed to promote and encourage the adoption of the alternative solutions tested with the pilots for the dairy industry sector.

In order to quantify expert opinion on certain issues (importance, interest, level of agreement, etc.), the same scale has always been used, ranging from 1 (not important/not interesting, totally in disagreement, etc.) to 9 (very important, very interesting, very much in agreement, etc.). For the analysis of the data obtained, the information has been categorized as 'low' when the score is between 1 and 4, 'medium' when it is between 4 and 6 and 'high' for those scores over 6. The tested pilots and their correspondent studied alternatives are shown in Annex 2 for more detail. Likewise, this work presents only a qualitative-descriptive analysis of the most important results of the different blocks. The descriptive analysis is supported by arithmetic means and information generated by the surveys.

5.3. RESULTS

The following results are the description of the information obtained according to the opinion of the experts interviewed for the dairy industry sector. It should be emphasized that this information has been based on a scale from 1 to 9 as detailed in the methodology above.

III.1. Level of concern and knowledge of the inorganic waste generation in the dairy sector as a problem and the alternatives in the market

With regard to the problem of inorganic waste generation in the global context and specifically in the dairy industry sector, the results collected according to the degree of knowledge and concern of the sector are shown in Table 5.1.

Table 5.1. Level of concern and knowledge of the sector about the problem of inorganic waste and alternative market solutions

Topic	Average
Degree of general knowledge of the waste problem in the sector	6,4
Level of concern about the problem of inorganic waste generated in the sector	5
Degree of knowledge of alternatives available on the market to reduce inorganic waste	5,2

Source: Own elaboration from the survey carried out within the framework of the REINWASTE project (2020)

As it can be seen from the data collected through the survey, the knowledge of the existing problem in the dairy sector is not so high (average 6,4) while the concern about the generation of waste is medium and, at the same way, also the sector's knowledge of the alternative solutions in the market to minimize, reduce or eliminate inorganic waste is medium (average 5,2).

Therefore it seems there is still “room” for increasing the awareness and knowledge of the sector about the problem of waste and the range of sustainable alternatives available in the market. This is to be considered a limiting factor for the introduction of possible innovations in the management of packaging waste.

III.2. Level of knowledge of the alternatives tested in the REINWASTE project pilots of the dairy industry sector

The results presented in this section are related to the direct knowledge that the dairy industry sector shown with regard to the alternatives tested in each of the pilots identified and carried out within the framework of the REINWASTE project. The results are summarised in Table 5.2.

Table 5.2. Knowledge of the alternatives tested in the REINWASTE pilots

Degree of knowledge of the alternatives of innovation	Average
1. Alternatives solutions to avoid over-packaging issue	
1.1. Light-weighting of plastic films for cheese packaging	8
2. Replacement of plastic with compostable materials obtained from renewable sources	
2.1. Replacement of trays with compostable ones	5,6
2.2. Replacement of conventional packaging for yogurt with compostable pots	4,6
3. Alternative solutions to improve the recyclability of packaging	
3.1. Replacement of composite materials with mono-materials	6,4
4. Integration of inspections on packaging lines in a protective atmosphere	
4.1. Adoption of non-destructive infra-red online control on packaged products	6,8

Source: Own elaboration from the survey carried out within the framework of the REINWASTE project (2020).

With regard to the knowledge that the sector has about the alternative solutions it is clear that the most known one is the innovation on light-weighting of plastic films for cheese packaging (average 8). At the same time other alternatives for which the dairy industry sector has a good knowledge are the replacement of composite materials by monomaterials (average 6,4) and the adoption of non-destructive infra-red online control on packaged products (average 6,8).

It is also necessary to highlight that, contrary to the above mentioned alternatives, the knowledge of the replacement of trays with compostable ones has a medium-low average (5,6). Considerably lower is also the knowledge of the replacement of conventional packaging for yogurt with compostable ones (average 4,6). Consequently, more emphasis should be placed on disseminating knowledge about the so called “biobased materials”, since they could play an important role in the

decrease of the generation of the packaging waste at plant level.

III.3. Potential for adoption of the alternatives tested in REINWASTE

Through this question, the potential for adoption by the dairy industrial sector is evaluated through expert knowledge based on the different alternatives tested in the REINWASTE project and commented in the previous section. The results are presented in Table 5.3.

Table 5.3. Potential adoption of the alternatives tested in the REINWASTE pilots

Degree of potential implementation of the following alternatives of innovation	Average
1. Alternatives solutions to avoid over-packaging issue	
1.1. Light-weighting of plastic films for cheese packaging	8,2
2. Replacement of plastic with compostable materials obtained from renewable sources	
2.1. Replacement of trays with compostable ones	7
2.2. Replacement of conventional packaging for yogurt with compostable pots	5,2
3. Alternative solutions to improve the recyclability of packaging	
3.1. Replacement of composite materials with mono-materials	7
4. Integration of inspections on packaging lines in a protective atmosphere	
4.1. Adoption of non-destructive infra-red online control on packaged products	8

Source: Own elaboration from the survey carried out within the framework of the REINWASTE project (2020).

In the potential for adoption that the sector has with respect to the available alternatives both the use of light-weighting of plastic films for cheese packaging and the adoption of non-destructive infra-red online control on packaged products showed a very good potential for adoption at plant level (average 8). Probably the reason is because both options have ensured full market uptake for the proposed solutions. The potential for adoption recorded by both the replacement of trays with

compostable ones and the replacement of composite materials with mono-materials is rather good (average 7). These solutions, indeed, have been tested concretely by the dairy companies even if research is still ongoing (especially for the use of compostable trays). However, the feeling is that dairy industry companies are ready to adopt in a near future the above-mentioned solutions.

With reference to the potential for adoption of the replacement of conventional packaging for yogurt with compostable pots it should also be noted that the sector has a medium predisposition to adopt this specific innovation (average 5,2). It is therefore clear that the sector has a great need for innovative alternatives for this type of plastic waste but now the thermoforming for PHBV (polyhydroxyalkanoate) is an actual challenge.

III.4. Limiting factors for the adoption of innovations in the dairy industry sector

To start, it is important to highlight that all the limiting factors that have been proposed in the survey are all considered to be of medium-high importance, since all the average punctuation obtained have been greater than 5.00 (Table 5.4) according to the scale from 1 to 9 considered (see methodology).

Table 5.4. Limiting factors in the adoption of the alternatives for the reduction of inorganic waste

Limiting factors	Average
Lack of knowledge from the supplier of the “new materials”	6,2
Low degree of technical update from the people involved in the Quality/Materials Dept.	6,4
Continuous changes of the regulatory framework (plastic taxes, deposit scheme, EPR fees…)	7
Assessment of food safety standards on food contact materials	7,8
Volatility of raw materials prices	6,8
Shelf-life assessment	8,6

Source: Own elaboration from the survey carried out within the framework of the REINWASTE project (2020).

Experts considered that aspects related to the shelf-life (average of 8,6) and the food safety assessments are limiting factors of a huge importance. Thus, both factors represent, still, a real barrier to the effective introduction of innovation regarding in particular the use of “biobased

materials" (i.e. bioplastics and compostable materials) which could highly contribute to improve the circularity and to reduce the generation of the packaging waste volumes at plant level. Another stage of limitations, on the same level, is represented by the variations occurred to the regulatory framework (national basis) and the volatility of raw materials (average 7 and 6,8 respectively). This is important because these limitations are related to "external" factors outside the plant. The less-retained limiting factors are represented by the lack of knowledge from the suppliers of "new materials" and the low degree of technical update from the people involved in the Quality dept. Both factors got the lower rate (average 6,2 and 6,4 respectively).

III.5. Promoting factors for the adoption of innovation in the dairy industry sector

The results obtained in relation to the factors that promote the adoption of the alternative measures for a better management of inorganic waste are shown below (Table 5.5)

Table 5.5. Promoting factors in the adoption of the alternatives for the reduction of inorganic

Promoting factors	Average
Marketing leverage	7,2
Consumer acceptance in terms of impact on sustainability	9
Improvement of CSR company strategy	6,8
Possible decrease of Environmental fee to be paid to national collection consortium system (CONAI, Corepla etc)	7,4
Reduction of packaging waste volumes	6,2
Others (please indicate):	

Source: Own elaboration from the survey carried out within the framework of the REINWASTE project (2020).

Respecting to the factors that promote the adoption of innovation, the sector perceives that the most important one is the consumer acceptance in terms of impact on sustainability, which received an average of 9. It is quite normal because at company level, when introducing an innovation, the perception of any changes by the consumers is considered largely relevant.

Based on the Italian regulatory framework the second-ranked factors is represented by the possibility to get reduction of the Environmental Fee which is paid by the company to the collection consortium system (CONAI[1], Corepla[2] etc). For example, the light-weighting or even the use of

1 Consorzio Nazionale Imballaggi www.conai.org

monomaterials innovations go under this direction (average 7,4).

Other factors which are perceived rather important are both the marketing leverage (7,2) and the improvement of the company Corporate Social Responsibility (CSR) strategy (average 6,8) and they are clearly connected to the consumer acceptance topic. The food companies (not only dairy) are very keen about how to valorise their engagement on the sustainability topic.

The factor considered with a lower rate of importance is the reduction of packaging waste volume (average 6,2) if considered itself. There is the need to link this aspect to the other above-mentioned factors to have a full view at company level.

2 Consorzio Nazionale per il riciclaggio, la raccolta e il recupero degli imballaggi in plastica www.corepla.it

III.6. Strategies to encourage the adoption of tested alternatives in the dairy industry sector to reduce and/or minimize the generation of inorganic waste

According to the knowledge and feedback collected by the experts who participated in this short survey, the following strategies are recommended for the dairy industry sector in order to promote the adoption of the alternatives tested within the framework of the REINWASTE project:

- Better involvement of plastic producers/processors and suppliers of packaging;
- Extensive dialogue with regional / national waste treatment facilities operators;
- Better use of funding schemes existing at national/regional to finance the necessary investments at plant level.

5.4. CONCLUSIONS

With regards for the industrial dairy sector, most of the waste generated by dairy companies is inorganic: primarily packaging waste from both raw and secondary materials as well as the final product. The recycling and treatment of waste generated in a dairy firm begins with separation, which avoids they are being discarded with liquid waste and by mixing together that would prevent adequate treatment of each type of waste.

During the testing activities carried out in the dairy industry companies it was clear that the packaging waste topic was considered an issue. However, during the audit it was remarked that the related costs were considered as fixed items (similar to the administrative expenses). Thus, it was difficult to quantify amounts of waste, because its management is usually subcontracted and the company pays a fixed cost for the service, irrespective of the amounts.

With respect to the measures proposed, all of them could bring benefits in terms of sustainability of the food chain. In particular:

- Lowering plastic use by packaging lightweighting allows reducing fossil sources exploitation and waste streams.
- LCA studies on bioplastic packaging report environmental advantages compared to conventional systems.
- The use of monomaterials improves recyclability levels. Environmental Contribution takes into account the potential environmental impact of packaging and fixes a fee, which is inversely related to recyclability.
- The adoption of non-destructive control systems prevents waste generation at the quality control level

However, any change in packaging systems needs feasibility assessment through comparative shelf life studies because food safeguard comes first. Innovative sustainable materials are available, the cost is expected to decrease in the next few years, as well as the waste management systems (specific composting and recycling) are expected to be implemented when the critical mass is reached.

Plastic should continue to be used, though in a wiser manner (i.e. optimisation of packaging materials in view of the best end-of-life and eco-design. R-PET represents an opportunity for plastic waste reduction, since it allows perfect circularity of plastic (return to the same use).

6. GENERAL CONCLUSIONS ABOUT THE POTENTIAL OF ADOPTION OF INNOVATIVE SOLUTIONS IN THE WHOLE AGRI-FOOD CHAIN

From the previous analysis of the potential of adoption of each of the three value chains some general conclusions can be drawn:

- Inorganic waste problem is very well known mostly by the horticultural sector, which shows higher level of knowledge and concern about it, especially for the horticultural production sector where high levels of inputs and waste generation are present and where the problem is more compelling. Dairy and meat value chains also show their knowledge and concerns about this problem, but with more medium levels.
- The agri-food companies (both, farms and industries) show in general medium knowledge about the solutions for the reduction of inorganic waste, showing heterogeneous levels depending on the specific solutions. The dairy sector (both agriculture and industry) and the horticultural industry show higher levels of knowledge of certain solutions, whereas horticultural production sector and the meat industry show lower levels.
- The agri-food sectors analysed show in general good potential to introduce innovative solutions to reduce inorganic waste. This potential of adoption is quite high for horticultural and dairy industries,

medium-high for horticultural production showing more medium or medium-low levels in the case of dairy production and meat industry sectors.

- One of the most limiting factors for the introduction of innovations is the still unavailability of materials and solutions with the sufficient technical feasibility. In this sense, there is still work to be done to improve new materials in order to reach the same technical characteristics of the conventional ones (for instance, food safety standards and shelf-life assessment have to be considered for the new solutions to be introduced in the industries). Another limiting factor identified is the higher costs or the need to do investments to introduce these changes which has been mentioned by the horticultural and meat chains. Other limiting factors identified mostly by industries is the continuous changes of the regulatory framework (plastic taxes, etc.), low degree of technical update from the people involved in the quality /materials departments or a lack of knowledge from the supplier of the "new materials". Finally, also a lack of research and innovation has been mentioned more from the farms side.
- In spite of the above limiting factors, there are some promoting factors that positively contribute to the adoption of innovations. The most important one is the increase in social awareness about inorganic waste problems and more willingness of consumers to introduce these changes. Therefore, companies implementing these innovations improve their image in the eyes of consumers gaining marketing leverage. An important shift that has been identified here is the fact that companies assume an environmental awareness themselves, beyond consumer demands, as the reduction of waste volumes, improvement of waste management and the social corporate responsibility have been also mentioned as promoting factors. In some specific cases, these changes can entail a reduction in some costs (such as the Possible decrease of Environmental fee to be paid to national collection consortium system mentioned in the dairy industry). In horticultural production, improvement of certain alternative materials (mulching and raffia staking elements) and associationism have also been considered to be favoring the adoption of innovations.
- To conclude, there are two most mentioned strategies to promote the adoption of innovative solutions to reduce waste and tackle the limiting factors, one of them is to improve funding schemes to finance the necessary investments to adopt alternative solutions in the companies and the other one is the promotion of research (e.g. biodegradable materials, monomaterials, non-destructive control systems, packaging lightweighting, LCA studies on bioplastic, feasibility assessment through comparative shelf life studies for food safeguard, etc.). There is a need to broaden the available solutions and make them applicable to companies with different characteristics. Also a better involvement of plastic producers/processors and suppliers of packaging would be necessary. Other strategies identified are in relation with the improvement of waste management. Some of them are to create specialist advisors on waste management, to build quality certifications in i-waste management, to promote an extensive dialogue with regional / national waste treatment facilities operators, to strengthen the infrastructures for the recycling of materials. Finally, strategies to raise

awareness of consumers about inorganic waste and environmental protection are considered key to make the whole shift work.

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7.2 POTENTIAL ADOPTION OF THE BEST INNOVATIVE SOLUTIONS IN THE DAIRY PRODUCTION

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7.3 POTENTIAL ADOPTION OF THE BEST INNOVATIVE SOLUTIONS IN THE DAIRY INDUSTRY

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8.ANNEXES

8.1 POTENTIAL ADOPTION OF THE BEST INNOVATIVE SOLUTIONS IN THE HORTICULTURAL PRODUCTION: ANNEX 1. QUESTIONNAIRE

Below we present the questionnaire regarding the potential adoption analysis of best available pilot solutions for horticultural farming. Please, mark with a cross the degree of agreement or disagreement for each statement, ranking from 1 to 9. Please, before answering this questionnaire, learn carefully the detailed guidelines provided jointly with this template for a better understanding

1. Given the problematic context of the generation of inorganic residues in a global context and concretely in the horticultural farming (indicate the corresponding value chain), please evaluate the degree of concern and knowledge for producers and industries of the following issues:

	Low			Medium			High		
	1	2	3	4	5	6	7	8	9
Degree of **concern** of the waste problematic in the sector									
Degree of general **knowledge** of the waste problematic in the sector									
Degree of **knowledge of the potential innovative solutions** available in the market to reduce inorganic waste									

2. Concretely, in the frame of the chosen implemented pilot tests in the horticultural sector (indicate the corresponding value chain), please evaluate the sector degree of knowledge of each of them. (Please see Annex for the description of selected ongoing pilots and their respective alternatives in the frame of REINWASTE). To answer this question, please adapt the content to each of the tested pilots and its corresponding alternatives.

	Low			Medium			High		
Degree of knowledge of the following innovative alternatives	1	2	3	4	5	6	7	8	9
1. Use of alternative materials for plant staking raffia									
1.1. Use of reusable raffia									
1.2. Use of compostable raffia 100% of natural origin									
1.3. Use of biodegradable raffia (mixture natural and bio-polymer)									
2. Use of alternative materials for plastic mulching									
2.1. Use of compostable plastic mulching									
2.2. Use of in soil biodegradable plastic mulching									
3. Energetic valorization of difficult-to-manage waste									
3.1. Valorization by pyrolysis									
3.2. Valorization by gasification									
4. Application of documentary traceability to waste management									
4.1. Use of a hard-copy based (physical) documentary traceability system									
4.2. Use of a documentary traceability software									
5. Comparison of different associative waste management models									
5.1. Agreement farmers´ association-									

single management company									
5.2. The farmers' association becomes waste manager									

3. In the same way, in the frame of the implemented pilot tests in the horticultural sector (indicate corresponding value chain), please evaluate the degree of potential implementation or adoption on these solutions by the sector. To answer this question, please adapt the content to each of the tested pilots and its corresponding alternatives.

	Low			Medium			High		
Degree of potential implementation of the following alternatives of innovation	1	2	3	4	5	6	7	8	9
1. Use of alternative materials for plant staking raffia									
1.1. Use of reusable raffia									
1.2. Use of compostable raffia 100% of natural origin									
1.3. Use of biodegradable raffia (mixture natural and bio-polymer)									
2. Use of alternative materials for plastic mulching									
2.1. Use of compostable plastic mulching									
2.2. Use of in soil biodegradable plastic mulching									
3. Energetic valorization of difficult-to-manage waste									
3.1. Valorization by pyrolysis									
3.2. Valorization by gasification									
4. Application of documentary traceability to waste management									
4.1. Use of a hard-copy based (physical) documentary traceability system									
4.2. Use of a documentary traceability software.									

5. Comparison of different associative waste management models									
5.1. Agreement farmers' association-single management company									
5.2. The farmers' association becomes waste manager									

4. According to your experience, evaluate the importance of each of the following limiting factors for the adoption of the tested innovative alternatives. Each partner could define these factors based on the information from the OSIP (Operative Strategy and Intervention Plan) and the SWOT (Strengthens, Weaknesses, Opportunities and Threatens) analysis performed in each value chain steps.

	Low			Medium			High		
Limiting factors	1	2	3	4	5	6	7	8	9
Numerous small size greenhouses with difficul to assume their own waste management									
Lack of knowledge from farmers about innovative alternatives available in the market									
Lack of education and information backgrounc producers respecting to waste management									
High cost and limited availability of alternati materials at an affordable price.									
High investments required for the implementat of innovative technologies									
Management cost for certain kind of inorga wastes									
Lack of guarantee and responsibilities from manufacturers of the innovations respecting their technical features									
Lack of specific managers for certain inorga wastes									
Lack of some inorganic waste managem traceability systems									

Lack of environmentally friendly alternatives thin plastics									
Lack of research and innovation areas minimizing waste at source									
Lack of proper technical characteristics w compostable and biodegradable raffia string									
Others (please indicate): ……									

5. According to your experience, evaluate the importance of each of the following factors that promote and encourage the adoption of the innovative alternatives. Each partner could define these factors based on the information from the OSIP (Operative Strategy and Intervention Plan) and the SWOT (Strengthens, Weaknesses, Opportunities and Threatens) analysis performed in each value chain steps.

	Low			Medium			High		
Promoting factors	1	2	3	4	5	6	7	8	9
Willingness to improve inorganic waste management by producers and their associations									
Technological innovation addressed in most of the companies to improve their efficiency using production resources									
Existence of public subsidies for some innovative alternatives									
Associationism that favors the scale economy and willingness to encourage collaboration among companies to promote joint waste management investments and favor scale economy to reduce costs									
Presence of authorized agents close to production area									
Willingness to encourage collaboration between companies to promote joint waste management investments (scale economy to reduce cost management)									
Important technological improvement of biodegradable strings and mulching									
The use of the alternatives to reduce the inorganic waste has positive effects on public health									
Higher social awareness in the agri-food value chain regarding to waste's generation									
Increasing demand and willingness to pay more for sustainable products that reduce waste by consumers									
Product differentiation linked to quality attributes of waste management "zero waste" and higher added value obtention and competitive advantage (opportunity market)									
Current research and innovation trends focused on									

valorization of waste, bio economy and circular economy									
Others (please indicate): ……									

6. Please, identify some strategies to encourage the adoption of the tested alternative pilots in horticultural greenhouses faming to reduce and/or minimize the inorganic waste. Each partner should adapt this question to their corresponding value chain.

Strategy to promote the adoption of the tested pilot alternatives
1.
2.
3.
4.
5.
6.

8.2 POTENTIAL ADOPTION OF THE BEST INNOVATIVE SOLUTIONS IN THE HORTICULTURAL PRODUCTION: ANNEX 2. PILOTS AND ALTERNATIVES IN THE HORTICULTURAL PRIMARY PRODUCTION SECTOR

PILOT 1: Use of alternative materials for plant staking raffia

Alternatives:

- Conventional practice: Use of polypropylene raffia.
- Alternative 1: Use of reusable raffia.
- Alternative 2: Use of compostable raffia 100% natural origin
- Alternative 3: Use of biodegradable raffia (mixture natural and bio polymer)

PILOT 2: Use of alternative materials for plastic mulching

Alternatives:

 Conventional practise: Use of low-density polyethylene.

 Alternative 1: Use of compostable plastic mulching.

 Alternative 2: Use of in soil biodegradable plastic mulching.

PILOT 3: Energetic valorization of difficult-to-manage waste Alternatives:

 Conventional practice: Use of conventional waste management channels.

 Alternative 1: Pyrolysis

 Alternative 2: Gasification.

PILOT 4. Application of documentary traceability to waste management

Alternatives:

 Conventional practice: Use of common documentary traceability control systems.

 Alternative 1: Use of a hard-copy based documentary traceability system.

 Alternative 2: Use of a documentary traceability software.

PILOT 5. Comparison of different associative waste management models

Alternatives:

 Conventional practice: Individual waste management

 Alternative 1: Agreement farmers' association-single management company

 Alternative 2: The farmers' association becomes waste manager

8.3 POTENTIAL ADOPTION OF THE BEST INNOVATIVE SOLUTIONS IN THE HORTICULTURAL INDUSTRY: ANNEX1.PILOTS AND ALTERNATIVES IN THE HORTICULTURE SECTOR IN THE FOOD INDUSTRY.

PILOT 1: Alternatives to the conventional use of plastic trays

Packaging is required to protect and preserve food products (primary packaging), and is used for grouping, transportation and as a marketing tool. Nowadays, the most common packaging used are conventional plastic trays.

In this first pilot, a PET tray is used as primary packaging, using a PE flowpack as closure. These trays revert in a great amount of plastic waste, both coming from the PET tray and from the PE flowpack, that in many cases is lost and cannot be recovered. Therefore, it is important to advance in the study of packaging alternatives that possesses less environmental impact, trying to advance towards zero inorganic residue.

Alternatives

- Alternative 0. Conventional plastic tray (PET) and flow pack (PE) made with conventional plastic materials.
- Alternative 1. Redesign of packaging to advance towards a more recyclable packaging (i.e., an all-in-one rigid plastic PET tray and closure)).
- Alternative 2. 85-100% rPET: Incorporate recycled material (recycled PET) in the packaging, while putting into the market a 100% recyclable PET package.
- Alternative 3. 100% biodegradable packaging, by using biodegradable plastics such as PLA.
- Alternative 4. Carton trays.

PILOT 2: LOGISTICS OPTIMIZATION

Alternatives

- Alternative 0. Conventional plastic tray and card-board secondary package. The two elements are not well fitted and, therefore, unnecessary residues coming from the card-board box are generated.

- Alternative 1. Change dimensions of the card-board box to better fit the dimensions of the plastic trays.
- Alternative 2. Rethink the whole packaging so it results in a more sustainable packaging tray that fits into a secondary packaging that should be adapted to the new tray.

PILOT 3: RETHINKING PACKAGING

Cucumbers are packaged in a cardboard tray with a flowpack (conventional plastic). It is a good starting point towards zero waste, but action is required to achieve improvements from an environmental point of view.

Alternatives:

Alternatives

- Alternative 0. Carton tray and conventional plastic flow pack.
- Alternative 1. Compostable plastic flow pack, to have a whole biodegradable packaging solution.
- Alternative 2. Cardboard tray with lid, to get rid of the plastic flow pack.

Alternative 3. Bands to substitute the whole package, so an almost zero waste solution is achieved

PILOT 4: SUSTAINABLE PACKAGING FOR GOURMET PRODUCTS

A very fancy plastic pot made from conventional PET plastic material (fossil resources) is used for the packaging of gourmet products. This format requires the use of great amount of plastic, much coming from the lid, and needs a very specific card-board box (secondary packaging) to fit them for transportation, which leads to great amounts of cardboard residues

Alternatives

- Alternative 0. Fancy PET pot that requires a lot of plastic for the lid and a special cardboard box for transportation.
- Alternative 1. Change the lid so less amount of plastic is used for its fabrication.
- Alternative 2. Redesign the packaging so it fit the “gourmet” concept but required less plastic material for its fabrication, while is better adapted to normal cardboard boxes.

PILOT 5: REDESIGN AND CHANGE OF MATERIALS

PP is used as packaging material. The packaging is fabricated by injection, resulting in a very robust pot which is consuming a lot of PP plastic for its fabrication. Moreover, PP is not very well recycled nowadays.

Alternatives

- Alternative 0. Robust PP pot fabricated following an injection process.
- Alternative 1. Eco-design the package so a PP pot can still use but employing less amount of PP for its fabrication.
- Alternative 2. Redesign packaging so it can be fabricated by a thermoforming process and with rPET as materials, which is recycled materials and it is a more recyclable material.

8.4 POTENTIAL ADOPTION OF THE BEST INNOVATIVE SOLUTIONS IN THE MEAT INDUSTRY: ANNEX1. QUESTIONNAIRE (French version)

Le questionnaire ci-dessous vise à analyser le potentiel d'adoption des solutions d'améliorations identifiées pour le secteur de la Viande dans le cadre du projet Reinwaste. Veuillez cocher d'une croix le degré d'accord ou de désaccord pour chaque énoncé, de 1 à 9.

1. En tenant compte du contexte mondial sur la problématique de la génération de résidus inorganiques dans le secteur de la viande, vous êtes invités à évaluer le degré de préoccupation et de connaissance des industriels français de la viande sur cet enjeu.

	Faible			Moyen			Élevé		
	1	2	3	4	5	6	7	8	9
Degré de **préoccupation** de la problématique des déchets plastiques dans le secteur									
Degré de **connaissance** générale de la problématique des déchets plastiques dans le secteur									
Degré de **connaissance des solutions innovantes** potentielles disponibles sur le marché pour réduire les déchets inorganiques									

2. Cette question vise à évaluer selon vous, le degré de connaissance des industriels de la viande de chacune des solutions identifiées dans le cadre du projet Reinwaste.

(Vous pouvez consulter l'annexe à la fin de ce document pour en savoir plus sur les solutions identifiées).

	Faible			Moyen			Élevé		
Degré de connaissance des alternatives	1	2	3	4	5	6	7	8	9

innovantes suivantes									
1. **Conditionnement des produits tranchés**									
1. Technologie sans squelette									
2. Barquette en film complexe scellée en mono PP									
3. Éviter de colorer avec des pigments foncés (suppression du noir de carbone)									
2. **Conditionnement des jambons entiers**									
1. Orienter les déchets vers la valorisation énergétique, valorisation matériaux complexes ou exiger des fournisseurs des matériaux recyclés ou biosourcés (PE)									
2. Un emballage unique dans un film type « meat adhésion »									
3. Un seul emballage sous film à valve									
4. Couplage avec le traitement à haute pression du jambon emballé									
3. **Ligne de thermoformage**									
1. Thermoformage des barquettes en mono APET au lieu des barquettes complexes en PVC-PE									
2. Thermoformage des barquettes en mono PET au lieu des barquettes complexes en PVC-PE									
4. **Ligne d'operculage (scellage)**									
1. Technologie under skin									
5. **Emballages Doypak**									
1. Suppression des becs verseurs et des bouchons									
2. Suppression de la couche d'aluminium									

6. **Conditionnement des plats cuisinés précuits**									
1. Remplacement d'une coque PET-PE par une coque mono PP									
7. **Couverts à usage unique dans les plats à emporter**									
1. Élimination des couverts à usage unique									
2. Remplacer les couverts en plastique par des couverts en matériaux tels que le bois ou même par des matériaux comestibles.									
3. Remplacer les couverts à usage unique par des couverts réutilisables									
4. Reconception de la fonction des couverts									

3. De la même manière, dans le cadre des tests pilotes mis en œuvre dans le secteur carné, veuillez évaluer le degré de mise en œuvre ou d'adoption potentielle de ces solutions par le secteur.

	Faible			Moyen			Élevé		
Degré de mise en œuvre potentielle des alternatives d'innovation suivantes	1	2	3	4	5	6	7	8	9
1. **Conditionnement des produits tranchés**									
1. Technologie sans squelette									
2. Barquette en film complexe scellée en mono PP									
3. Éviter de colorer avec des pigments foncés (suppression du noir de carbone)									
2. **Conditionnement des jambons entiers**									
1. Orienter les déchets vers la valorisation énergétique, valorisation matériaux complexes ou exiger des fournisseurs des matériaux recyclés ou biosourcés (PE)									

2. Un emballage unique dans un film type « meat adhésion »									
3. Un seul emballage sous film à valve									
4. Couplage avec le traitement à haute pression du jambon emballé									
3. **Ligne de thermoformage**									
1. Thermoformage des barquettes en mono APET au lieu des barquettes complexes en PVC-PE									
2. Thermoformage des barquettes en mono PET au lieu des barquettes complexes en PVC-PE									
4. **Ligne d'operculage (scellage)**									
1. Technologie Under skin									
5. **Emballages Doypak**									
1. Suppression des becs verseurs et des bouchons									
2. Suppression de la couche d'aluminium									
6. **Conditionnement des plats cuisinés précuits**									
1. Remplacement d'une coque PET-PE par une coque mono PP									
7. **Couverts à usage unique dans les plats à emporter**									
1. Élimination des couverts à usage unique									
2. Remplacez les couverts en plastique par des couverts en matériaux tels que le bois ou même par des matériaux comestibles.									
3. Remplacer les couverts à usage unique par des couverts réutilisables									

4. Re-conception de la fonction des couverts									

4 Selon votre expérience, évaluez l'importance de chacun des freins suivants pour l'adoption des alternatives innovantes identifiées.

	Faible			Moyen				Élevé	
Freins :	1	2	3	4	5	6	7	8	9
Coûts des matériaux alternatifs									
Disponibilité des matériaux									
Risques sanitaires : étanchéité des emballages									
Risques sanitaires : aptitude au contact alimentaire									
Propriétés barrières : réduction de la durée de vie									
Réduction de la résistance mécanique									
Réduction de la résistance à la température									
Incompatibilité avec une cuisson /chauffe au micro-onde									
Autres (veuillez les indiquer) ……									

5 Selon votre expérience, évaluez l'importance de chacun des leviers suivants qui favorisent et encouragent l'adoption des alternatives innovantes.

	Faible				Moyen		Élevé		
Leviers :	1	2	3	4	5	6	7	8	9
Réduction des coûts									
Respect de la réglementation									
Amélioration de l'image de l'entreprise									
Engagement RSE de l'entreprise									

Image d'un produit plus vertueux									
Sensibilité des consommateurs									
Autres (veuillez les indiquer)……									

6 Veuillez proposer une ou plusieurs recommandations qui permettraient selon vous de faciliter l'adoption des solutions alternatives identifiées dans les entreprises du secteur de la viande pour réduire et / ou minimiser les déchets plastiques.

Stratégies pour promouvoir l'adoption des alternatives pilotes testées :
1. exemple : Rédiger un logigramme d'aide à la décision pour remplacer un matériau complexe par un matériau recyclable pour une barquette thermoformée.
2. Recommandation politique : encourager les entreprises à adopter des solutions alternatives grâce à des soutiens techniques et financiers régionaux et nationaux
3. Encourager les projets de recherche et le développement de nouvelles solutions alternatives
4.
5.
6.

8.5 POTENTIAL ADOPTION OF THE BEST INNOVATIVE SOLUTIONS IN THE DAIRY PRODUCTION: ANNEX1. QUESTIONNAIRE

Below we present the questionnaire regarding the potential adoption analysis of best available pilot solutions for DAIRY SECTOR (SEGMENT AGRICULTURE).

Please, mark with a cross the degree of agreement or disagreement for each statement, ranking from 1 to 9. Please, before answering this questionnaire, learn carefully the detailed guidelines provided jointly with this template for a better understanding.

1. Given the problematic context of the generation of inorganic residues in a global context and concretely in the DAIRY SECTOR (SEGMENT AGRICULTURE), please evaluate the degree of concern and knowledge for producers and industries of the following issues:

	Low			Medium			High		
	1	2	3	4	5	6	7	8	9
Degree of **concern** of the waste problematic in the sector									
Degree of general **knowledge** of the waste problematic in the sector									
Degree of **knowledge of the potential innovative solutions** available in the market to reduce inorganic waste									

2. Concretely, in the frame of the chosen implemented pilot tests in the DAIRY SECTOR (SEGMENT AGRICULTURE), please evaluate the sector degree of knowledge of each of them. (Please see Annex for the description of selected ongoing pilots and their respective alternatives in the frame of REINWASTE). To answer this question, please adapt the content to each of the tested pilots and its corresponding alternatives.

	Low			Medium			High		
Degree of knowledge of the following innovative alternatives	1	2	3	4	5	6	7	8	9

	Low			Medium			High		
Degree of knowledge of the following innovative alternatives	1	2	3	4	5	6	7	8	9
PILOT 1: REDUCTION OF ROUND BALE NETS									
5.3. Alternative 1.Use of round bale net with a 5 % lower weight									
5.4. Alternative 2. Polypropylene twine									
5.5. Alternative 3. SISAL twine									
5.6. Alternative 4. Use of the Big Baler									
5.7. Alternative 5. Use of the two-stage haymaking process of loose hay									
6. Pilot 2. REDUCTION OF PLASTIC SILAGE FILM BECAME WASTE									
6.1. Alternative 1. Use silage film of less thickness									
6.2. Alternative 2. Use of haylage round bales									

NOTE: The study highlighted that the economic and environmental benefits of each alternative solution to the use of traditional plastic materials cannot be considered universally valid for all farms in the livestock sector. Therefore, the choice of an alternative solution to the traditional one will be evaluated on the basis of the company characteristics (size, management, production cycle).

3. In the same way, in the frame of the implemented pilot tests in DAIRY SECTOR (SEGMENT AGRICULTURE), please evaluate the degree of potential implementation or adoption on these solutions by the sector. To answer this question, please adapt the content to each of the tested pilots and its corresponding alternatives.

	Low			Medium			High		
Degree of potential implementation of the following alternatives of innovation	1	2	3	4	5	6	7	8	9
PILOT 1: REDUCTION OF ROUND BALE NETS									

	Low			Medium			High		
Degree of potential implementation of the following alternatives of innovation	1	2	3	4	5	6	7	8	9
1.1. Alternative 1.Use of round bale net with a 5 % lower weight									
1.2. Alternative 2. Polypropylene twine									
1.3. Alternative 3. SISAL twine									
1.4. Alternative 4. Use of the Big Baler									
1.5. Alternative 5. Use of the two-stage haymaking process of loose hay									
2. Pilot 2. REDUCTION OF PLASTIC SILAGE FILM BECAME WASTE									
2.1. Alternative 1. Use silage film of less thickness									
2.2. Alternative 2. Use of haylage round bales									

NOTE: The study highlighted that the economic and environmental benefits of each alternative solution to the use of traditional plastic materials cannot be considered universally valid for all farms in the livestock sector. Therefore, the choice of an alternative solution to the traditional one will be evaluated based on the company characteristics (size, management, production cycle).

4. According to your experience, evaluate the importance of each of the following limiting factors for the adoption of the tested innovative alternatives.

	Low			Medium			High		
Limiting factors	1	2	3	4	5	6	7	8	9
the alternatives cannot be considered universally valid for all farms in the livestock sector									
The impact of the solution available									
The waste management now it is not perceived as a problem									

5. According to your experience, evaluate the importance of each of the following factors that promote and encourage the adoption of the innovative alternatives.

	Low			Medium			High		
Promoting factors	1	2	3	4	5	6	7	8	9
incentives									
information									

6. Please, identify some strategies to encourage the adoption of the tested alternative pilots in DAIRY SECTOR (SEGMENT AGRICULTURE) to reduce and/or minimize the inorganic waste. Each partner should adapt this question to their corresponding value chain.

7 Strategy to promote the adoption of the tested pilot alternatives

incentives

information

8.6 POTENTIAL ADOPTION OF THE BEST INNOVATIVE SOLUTIONS IN THE DAIRY PRODUCTION: ANNEX2. PILOTS AND ALTERNATIVES

PILOT 1: ALTERNATIVE SOLUTIONS TO CONVENTIONAL ROUND BALE NETS (high density polyethylene) Mesh net casing used for packing cylindrical bales

• Alternative 1.Use of round bale net with a 5 % lower weight
Mesh net casing with reduced thickness used for packing cylindrical bales
• Alternative 2. Polypropylene twine
Thin rope casing made of polypropylene used for the packaging of bales
• Alternative 3. SISAL twine
Thin rope Sisal wrapper used for packing bales.
Sisal (vegetable textile fiber derived from the leaves of Agave sisalana)
• Alternative 4. Use of the Big Baler
High density pressing for the packaging of large prismatic bales
• Alternative 5. Use of the two-stage haymaking process of loose hay
Haymaking technique which involves a first pre-drying phase in the field and a second phase in which the product is brought loose in the barn to complete drying.

PILOT 2: ALTERNATIVE SOLUTIONS TO CONVENTIONAL USE OF PLASTIC SILAGE FILM (Plastic films for covering and protecting silage in order to guarantee their shelf life.)

- Alternative 1. Use silage film of less thickness

Plastic films for covering and protecting silage in reduced thickness trenches with the use of smaller quantities of plastic materials.

- Alternative 2. Use of haylage round bales

Silage technique that involves the complete wrapping of the bales by plastic films.

Legend of the stakeholders

1. green: farmer
2. Red: organic expert
3. Purple reinwaste expert
4. Yellow fodder producer
5. Light blu: the researcher