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POTENTIAL ADOPTION OF THE BEST INNOVATIVE SOLUTIONS IN AGROFOOD VALUE CHAINS





INTRODUCTION

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.

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 farm/agroindustry). In general, producers who adopt an innovation first (pioneers) require a shorter period of acceptance or approval than those who adopt it later.

In the framework of the REINWASTE project, different innovative solutions (also called BATs, Best Available Techniques) have been identified

to overcome with the problem of inorganic waste generated in three different agri-food value chains (horticulture in Spain, dairy in Italy and meat in France). Among them, some solutions have been selected to be implemented through pilot tests in the field/industry in those value chains.

The main aim of the present document is to analyse the potential of adoption of the innovative solutions identified and tested in the pilot tests carried out in the framework of REINWASTE project, identifying the most important limiting/promoting factors that hinder or favour their adoption, offering strategies that serve to encourage farmers and industries for their adoption.



METHODOLOGY

The information used to analyze the potential for the adoption of innovative solutions in the agrifood value chain was obtained from surveys of between 5-16 experts from the three value chains analysed at farm or industry level. These experts chosen have the following profiles: researchers, technicians from the sector, managers, experts in packaging materials and processes of food

industry, farmers, food industries and fodder producers. The surveys were carried out along the year 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 when necessary, before executing the final survey. The survey carried out is structured in the following blocks:

- Level of concern and knowledge of the sector about the problems of inorganic waste and alternative market solutions
- Level of knowledge of the alternatives tested in the pilots of the REINWASTE project in each value chain
- Potential for adoption of the alternatives tested in REINWASTE
- Limiting factors in the adoption of innovations in each value chain
- Promotional factors in the adoption of innovations in each value chain
- 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

This document presents only a qualitative-descriptive analysis of the most important results of the different blocks. Not all the items mentioned above are included in the sector analysis (e.g., level of concern and knowledge), but the general conclusion at the end of this document include considerations from all those aspects



HORTICULTURAL PRODUCTION

The **potential of adoption** of all the alternatives tested by REINWASTE in the horticultural production sector has been measured as medium-high, so in general, there is a good predisposition to implement innovative solutions in this sector that minimize or avoid the generation of waste.

More specifically, the potential for adoption of alternatives to mulching (compostable and biodegradable) by the horticultural sector is high, in fact they obtain the highest score.

Concerning the available alternatives for staking elements or raffias, all of them (compostable, reusable, and biodegradable raffia) obtain a medium-high predisposition to be used. The problems generated by conventional raffia, especially in relation to the remains of these staking elements in vegetable waste (which make the treatment or composting of plant remains difficult), make the sector has a higher predisposition to adopt them.

With reference to the alternatives for energetic valorization of difficult-to-manage waste tested in the project (valorization by pyrolysis and valorization by gasification), the sector has a medium predisposition to adopt these techniques. It is therefore clear that the sector has a need for innovative alternatives for this type of plastic waste.

With regard to the alternatives for documentary traceability of inorganic waste, the predisposition to adopt the alternatives tested is medium, and producers perceive the physical documentary traceability system as more feasible than using the software, 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 offered in the horticultural sector is medium, although the sector is more inclined to adopt the alternative where companies establish waste management agreements with a single management company than the alternative in which the farmers' association becomes waste manager.

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.

The main social, technical and economic **factors identified 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 staking elements and mulching plastics,
- Associationism as a factor promoting innovation,
- The willingness of producers to make technological and waste management improvements.

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.

HORTICULTURAL INDUSTRY

According to the survey, there is a high **potential of adoption of the solutions** tested in the horticultural industry in the REINWASTE framework. The ones showing a better potential of adoption are those considering 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 cardboard trays and bands to substitute the whole packaging. 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.

Experts considered that aspects related to necessary investments 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 departments.

Concerning the **factors that promote the adoption of innovation**, the horticulture sector feels that the most important one is the consumer acceptance in terms of impact on sustainability. 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 and the improvement of the company Corporate Social Responsibility (CSR) strategy which are also 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.

According to the knowledge and feedback collected by the experts who participated in this 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



DAIRY PRODUCTION

The **potential of adoption** that the sector has with respect to the available alternatives showed a medium/low interest for both pilots tested in dairy production. The reason is the lack of innovation on this topic so there is the need to 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 that the alternatives cannot be considered universally valid for all farms in the livestock sector. 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. Another important limiting factor for the adoption is the fact that waste management nowadays is not perceived as a problem by the sector.

The identified **promoting factors** for this supply chain are incentives for farmers and information campaigns. In fact the **strategies** proposed are in line with these promoting factors. Concerning incentives, proposals to draft specific measures included in the Rural Development Plan (PSR) are mentioned by some experts. Others mentioned the introduction of priorities for access to the PSR measure, or specific allowances for the purchase of machinery and equipment to reduce waste. Concerning information campaigns, a demo day is proposed to make farmers understand which are the advantages of investing on environmental purposes, to overcome the limiting factor of not seeing the waste issue as a problem and to increase their willingness to introduce measures towards the reduction.

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. 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. Experts considered that aspects related to the shelf-life 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. 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 department. Both factors got the lowest rate. 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. 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, Corepla, etc.). For example, the light-weighting or even the use of monomaterials innovations go under this direction.

Other factors which are perceived rather important are both the marketing leverage and the improvement of the company Corporate Social Responsibility (CSR) strategy which 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 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.

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 light weighting allows reducing fossil sources exploitation and waste streams.
- LCA (Life Cycle Assessment) 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).



MEAT PRODUCTION

From a technical point of view, the main **limiting factor** to the adoption of new types of round bale nets or hay bale twine made from recycled plastic is the lack of strength of the new materials. On the organizational level, the ADIVALOR system for sorting, collecting and recycling inorganic farm waste presents 3 factors that can still hinder the deployment of collection and recycling operations: climate and topography of the areas (snow periods, mountainous areas), logistics costs, particularly for the suppliers of farmers who make their facilities and platforms available without financial compensation, and the global context due to the few plants specialized in recycling used plastics in France which is disrupting the industry, among other factors.

Concerning **the promoting factors**, plastics manufacturers are aware of the technical difficulties raised by breeders. A rapprochement between manufacturers of plastics for agriculture is underway to study the factors limiting the development of these new technologies and to bypass them.

At the national level, French farmers are very receptive to the management of their inorganic waste. They have been involved since the early 2000s in the collection and recycling of all types of inorganic waste. One way to further promote

collection operations is to strengthen direct communication with the farmer. The increasingly frequent use of the media and social networks is a promising avenue.

Among the **strategies** proposed for reducing inorganic waste in the meat production the following can be stand out:

The strengthening of links between farmers, plastics manufacturers and the recycling industry must continue. ADIVALOR and the APE (European Association of Plastic Manufacturers) are structures whose durability must be ensured. At the technological level, the farming sector is demanding specifications adapted to the needs of the meat sector in order to create nets and twines adapted and sufficiently resistant based on compostable materials.

Relying on agricultural development networks and training institutions for future farmers. A large-scale operation is being set up by ADIVALOR with the experimental farms of the country's agricultural high schools. Students will be able to use new containers and improve the sorting and collection process of plastics on the farms.

More generally, the cost of the collection operations set up by ADIVALOR, agricultural advisory bodies and suppliers is significant (the eco-contribution does not cover all the costs of the collection and recycling chain) which makes necessary to mobilize a small part of the public funds to ensure the sustainability of the system.

MEAT INDUSTRY

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 law in terms of environmental aspect, the improvement of the company image, the company commitment in RSE (Corporate Social Responsibility)

- 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.



GENERAL CONCLUSIONS

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 and 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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REINWASTE website : <https://reinwaste.interreg-med.eu/>