NEWFEED

Turn Food Industry By-products into Secondary Feedstuffs via Circular-Economy Schemes

Grant Agreement number: 2013, Call 2020 Section 1 Farming IA

Identification of hurdles and bottlenecks

Deliverable number 1.1

Work Package 1	Alternative feed value chains appraisal through a multi-actor approach
Task 1.1	Alternative feed value chains appraisal through a multi-actor approach
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Foreword

The work described in this report was developed under the project NEWFEED: Turn Food Industry By-products into Secondary Feedstuffs via Circular-Economy Schemes (Grant Agreement number: 2013/ Call 2020 Section 1 Farming IA). If you wish any other information related to this report or the NEWFEED project please visit the project web-site (www.newfeed-prima.eu) or contact:

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PU	Public	X
PP	Restricted to other programme participants (including the Commission Services)	
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Executive Summary

This deliverable provides the ***obstacles and bottlenecks of the 3 value chains*** (from raw materials to consumers) ***that may affect the use of alternative raw materials as secondary feedstuffs for animal feed***.

These three value chains are:

1) Use of **grape stems** from wineries for sheep and dairy cattle.

2) Use of **orange peel** from orange juice industries for dairy sheep.

3) Utilization of **by-products from the olive oil industry** for poultry.

The analysis of the data obtained will allow the detection of obstacles and bottlenecks affecting the implementation of valorisation solutions, as well as the identification of success stories, to ensure the successful valorisation of these by-products as alternative ingredients for animal feed.

Three value chains in the Mediterranean area will be validated and new business opportunities will be created considering a multi-stakeholder approach in their conception, configuration and sustainability assessment:

1. The first case study will evaluate the use of grape stems from wineries as a second-generation ingredient for ruminant feed (sheep and dairy cows). This case study is led by AZTI (www.azti.es) and will be validated in Spain.
2. The second case study will evaluate the use of orange peel from the orange juice industry to produce an improved ingredient for ruminants (dairy sheep). This case study is led by the National Technical University of Athens (NTUA) and will be validated in Greece.
3. The third case study will evaluate the use of by-products from the olive oil industry to produce an improved ingredient for poultry (broilers). This case study is led by Heliopolis University for Sustainable Development (HUSD) and will be validated in Egypt.

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1. Introduction

The overall objective of the project is to develop alternative feed ingredients using a circular economy approach through the conversion of food by-products into high-value secondary animal feed.

The purpose of this Deliverable is to identify the obstacles and bottlenecks in 3 value chains (from raw materials to consumers) that may affect the use of these alternative raw materials as secondary feedstuffs for animal feed. These three value chains are:

1) Use of grape stalks from wineries for sheep and dairy cattle.

2) Use of orange peel from orange juice industries for dairy sheep.

3) Utilization of by-products from the olive oil industry for poultry.

The analysis of the data obtained will allow the detection of obstacles and bottlenecks affecting the implementation of valorisation solutions, as well as the identification of success stories, to ensure the successful valorisation of these by-products as alternative ingredients for animal feed.

Three value chains in the Mediterranean area will be validated and new business opportunities will be created considering a multi-stakeholder approach in their conception, configuration and sustainability assessment:

- ✓ The first case study will evaluate the use of grape stems from wineries as a second-generation ingredient for ruminant feed (sheep and dairy cows). This case study is led by AZTI (www.azti.es) and will be validated in Spain.
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- ✓ The third case study will evaluate the use of by-products from the olive oil industry to produce an improved ingredient for poultry (broilers). This case study is led by Heliopolis University for Sustainable Development (HUSD) and will be validated in Egypt.

2. Methodology

The main working tools are **interviews and questionnaires** to main stakeholders of the industries involved to identify the obstacles and bottlenecks in 3 value chains (from raw materials to consumers) that may affect the use of these alternative raw materials as secondary feedstuffs for animal feed. For this purpose, the following questions have been defined for each stage of the value chain:

1. Food industry:
    - Which kind of organic by-product do you generate?
    - What quantity of your organic by-products do you produce?
    - Is the generation of your organic by-products seasonable?
    - What is the current management of your organic by-products?
    - If it is valorised / recycled / reused, which application?
    - Do you have to pay or charge for its management?
    - Which are the main problems that you face in the management of the by-product?
    - In relation to Separation in origin, which are your main problems?
    - In relation to Storage, which are your main problems?
    - In relation to Transportation, which are your main problems?
    - In relation to Progressing, which are your main problems?
    - In relation to Commercialization, which are your main problems?
    - If you have selected Other, which are your main problems?
    - Would you be interested in a technology solution to valorise your organic by-products for animal feed?
    - Would you like the NEWFEED team to provide you a tailored treatment solution for your company?
    - Any information you can consider interesting.
2. Logistic & processing:
    - What type of by-products do you currently collect or valorise?
    - What quantity of organic by-products do you collect or valorise?
    - Which are the main issues in collecting and valorising waste/ industrial by-products as raw material?
    - In relation to Separation in origin, which are your main problems?
    - In relation to Storage, which are your main problems?
    - In relation to Transportation, which are your main problems?
    - In relation to Progressing, which are your main problems?
    - In relation to Commercialization, which are your main problems?
    - If you have selected Other, which are your main problems?
    - Would you be interested in a technology solution to valorise your organic by-products for animal feed?
    - Would you like the NEWFEED team to provide you a tailored treatment solution for your company?
    - Any information you can consider interesting.
3. Feed industry & Livestock:
    - Do you currently include any organic by-product as an ingredient in the formulation?
    - If yes, what amount?
    - If not, why?
    - If not, would you include a new ingredient produced from organic by-products in your diets?
    - What are the most important requirements when integrating a new ingredient in your formulations?
    - In relation to Price, which are your main requirements?
    - In relation to Nutritional value, what you would be interested in?

- In relation to Supply guaranties, what you would be interested in?
- In relation to Sustainability, what you would be interested in?
- In relation to Food safe, which are your requirements?
- In relation to Origin / Traceability, which are your requirements?
- In relation to Consumer acceptance, what would be your concerns?
- If you have selected other requirement, what would be your concerns?
- Would the inclusion of enriched ingredients such as antioxidants, immunostimulatory, etc. add value to the final feed?
- If yes, would you be willing to pay the extra cost?
- Any information you can consider interesting.

In addition, a **literature search for success stories in the valorisation of by-products to be used as animal feed** has been performed.

All the obtained information will be analysed to detect hurdles and bottlenecks that prevent the full implementation of valorisation solutions.

3. Case study 1 - Grape stems value chain

3.1 Chemical composition

The chemical composition of grape stem-based ingredients from the Baigorri winery is presented in Table 1. There have been several reviews conducted to analyse the nutritional composition of grape stems and other by-products generated in winemaking. The primary conclusion drawn from these reviews is that comparing data can be challenging due to variations in samples, including factors such as grape variety, vintage, maturity, and differences in extraction processes.

Water constitutes the major component of fresh grape stems, ranging from 55 to 80 percent of their total weight. Consequently, a stabilization process is necessary to prevent degradation. In our study, the initial moisture content of the grape stems was found to be 70 percent. Following the stabilization process through flash drying, the water content was reduced significantly to 7.43 percent. At this reduced moisture level, the ingredient can be stored for extended periods without the risk of microbial degradation.

Table 1. Grape stem composition.

Parameters	Unit	Value
Moisture	%	7.43
Ashes	%	6.28
Energy	kJ/100 g	1480
Protein	%	4.07
Total Carbohydrates	%	81.58
Neutral detergent fibre	%	40.81
Acid detergent fibre	%	40.81
Lignin acid detergent	%	19.72
Crude fat	%	0.64
Starch	%	4.90
Total sugars (expressed in glucose)	%	19.74

Dried grape stems are characterized by low protein and starch content concomitant with a high fibre content resulting in a relatively low gross energy containing raw material. Total sugar concentration can vary depending on the quantity of grape that has not been well separated from the grape stem.

In relation to grape stems, there are several hazards related to microorganisms and pesticides:

- Microbial contamination: Grape stems, due to their high moisture content, can provide a favourable environment for the growth of microorganisms such as bacteria, yeast, and molds. These microorganisms can cause material decomposition and the production of toxic or undesirable substances.

- Pathogen risk: If grape stems are not handled properly, they could potentially contain human or animal pathogens, such as *Salmonella* or *E. coli*, which could cause a health risk if products made from them are consumed.
- Pesticide residues: Pesticides used in vineyards may remain in grape stems. If not adequately removed or washed, pesticide residues can persist in the final products, which could have implications for food safety and health.
- Possible accumulation of undesirable compounds: Grape stems may also contain undesirable compounds, such as fungicide or herbicide residues, which could be harmful to human health if ingested in large quantities.

Therefore, it is essential to take appropriate hygiene and quality control measures when using grape stems in feed or food production or vineyard-related products to mitigate these potential risks and ensure consumer safety.

Table 2 shows the information related to the potential hazards of grape stem raw material.

Table 2. Grape stem hazards composition.

Parameters	Units	Detection limit	Results
Nitrates	mg / kg	< 10	331.7
Nitrites	mg / kg	< 10	56
Pb	mg / kg		0.045626402
Cd	mg / kg		0.001334744
As	mg / kg		0.008646689
Hg	mg / kg		<0.05
Aerobic mesophiles	ufc / g		1.1×10^4
Escherichia coli	ufc / g		$< 10^2$
Salmonella	/ 25g		Absence
Staphylococcus aureus	ufc / g		$< 10^2$
Enterobacteria	ufc / g		< 10
Coliforms	ufc / g		$<10^2$
Clostridium perfringes	ufc / g		< 10
Listeria	/ 25g		Absence
Molds	ufc / g		$<10^2$
Yeast	ufc / g		$8.0x10^2$
Aflatoxin B1			< 0.5
Aflatoxin B2	µg / kg	0.5	< 0.5
Aflatoxin G1			< 0.5

Aflatoxin G2			< 0.5
Zearalenona	µg / kg	5,0	< 5.0
Deoxynivalenol (Vomitoxina)	µg / kg	50	< 50
Ocratoxin A	µg / kg	0.3	< 0.3
Fumonisin B1	µg / kg	50	< 50
Fumonisin B2	µg / kg	50	< 50
T-2	µg / kg	50	< 50
HT-2	µg / kg	50	< 50
Aldrin	mg / kg	0.01	< 0.01
Chlordane	mg / kg	0.01	<0.01
DDT	mg / kg	0.01	< 0.01
Endosulfan	mg / kg	0.01	< 0.01
Endrin	mg / kg	0.01	< 0.01
HCH	mg / kg	0.01	< 0.01
Heptachlor	mg / kg	0.01	< 0.01
Hexachlorobezene	mg / kg	0.01	< 0.01

To ensure the safety of grape stems intended for processing or consumption, a comprehensive approach is necessary. This includes adhering to Good Agricultural Practices (GAP) during cultivation to minimize contamination risks through responsible pesticide use, hygiene practices, and water quality control. Additionally, it's crucial to focus on proper harvesting and handling methods to reduce contact with contaminants, maintain appropriate storage conditions to prevent mold and bacterial growth, and conduct regular monitoring for pesticide residues and microbiological contamination. Hygiene and sanitization protocols must be implemented during processing and packaging, and ongoing quality control measures should be in place to detect any physical signs of contamination, such as mold growth or off-odors. By consistently monitoring, testing, and adhering to food safety regulations and guidelines, the presence of contaminants can be effectively addressed and mitigated.

3.2 Hurdles and Bottlenecks identified

Grape stem value chain consists of the use of grape stems from wineries as a second-generation ingredient for ruminant feed (sheep and dairy cows).

Primary activities of the grape stem value chain consist of six main components, and all are essential for adding value and creating competitive advantage to the new advanced feedstuff. The six components of the value chain of grape stems are the following:

- ✓ **Raw material:** In our case the secondary raw material producer is winery industry.
- ✓ **Inbounds logistic** includes the procedure for separation of the grapes from the stalks converting grape stems into finished product.
- ✓ **Operations** include the procedures for converting grape stems into finished product -dairy sheep and cattle feedstuff and these procedures will be defined in WP2 and WP3.
- ✓ **Outbound logistics** include activities to distribute the final product to a consumer.
- ✓ **Marketing and sales** include strategies to enhance visibility and target appropriate customers—such as advertising, promotion, and pricing.
- ✓ **The End-users** that are mainly Animal feed companies, Animal feed distributors, Farmers and Sheep products consumers.

The methodology for the identification of the hurdles and bottlenecks related to the value chain of grape stems involves the following steps that are thoroughly analysed in the following sections:

- ➢ The production of a **list of main stakeholders** classified according to the value chain as Raw material producers and End-users. Wineries, animal feed producing and distribution companies and farmer associations.
- ➢ The distribution of a **questionnaire** comprised of the questions that have been referred in Section 2 of this present Deliverable to the stakeholders identified at the previous step.

More specifically, the identification of hurdles and bottlenecks for the case of grape stem value chain is distributed in the following steps:

- ➢ A brief description of the respective sector and the current situation
- ➢ The analysis and interpretation of the results obtained from the questionnaires and a more detailed discussion on the results.
- ➢ Main conclusion of the hurdles and bottlenecks related to each group

In the case of questionnaires, a total of 10 answers has been obtained, which represent the different actors in the whole value chain, 30 % from the food industry, 30 % from the feed industry, 20 % from logistics and valorisators and the last 20 % from the livestock.

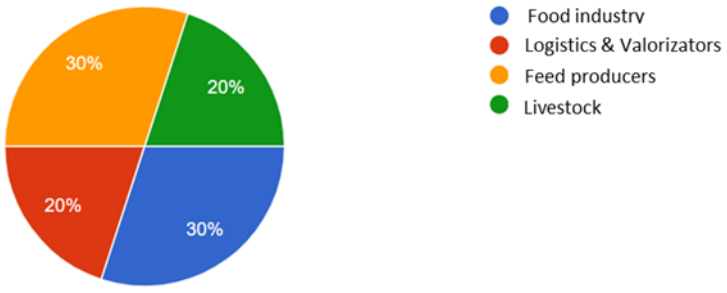


Figure 1. *Percentage of answers by sector*

The number of employees was less than 10 in the 40 % of the responses, between 10-49 employees in the 30 % of the responses, higher than 250 employees in 20 % of the responses and between 50-249 in the 10 %.

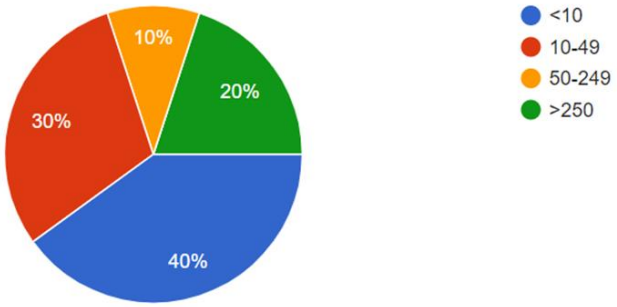


Figure 2. *Number of employees by company and response*

3.2.1 Food industry

EU is the world-leading producer of wine with an average annual production of 167 million hectolitres (Eurostat 2019), that suppose the 45 % of world wine-growing areas and the 65 % of production. In 2018, Italy (48.5 Mhl), France (46.4 Mhl) and Spain (40.9 Mhl) accounted for more than the 75 % of EU production. Among the winery by-products, grape stems, pomace, and lees are the most significant ones, in which, grape stems represent 1.4-7.0 % of the initially processed raw matter.

Currently, grape stems are not valorised as highly profitable by-products and are sent for composting or discarded in open areas, causing environmental impacts. Although the benefits of using these by-products as feed ingredients have already been proven, there is still the need identifying the hurdles and bottlenecks of the whole value chain to overcome them and thus be able to implement solutions for their valorisation.

A total of 3 responses from the food industry were analysed. All of them produced winery by-products. In addition, one of them also produces olive pomace and by-products from cereals, nuts and milk industry. In the table 3, we summarize some of the answers related to by-product generation.

Table 3. *Analysis of Winery industries responses to questions*

Question	**Answer**	**Gravity factor/hurdle**
What quantity of organic by-products do you produce?	1. < 100 tn/y	50,0 %
	2. 10000-50000 tn/y	50,0 %
Is the generation of your organic by-products seasonable?	3. < 3 months	66,0 %
	4. 3-6 months	33,0 %
What is the current management of your organic by-products?	5. Valorisation/Recycling	66,6 %
	6. Manage as a waste	33,0 %
If it is valorised/	7. Food industry	50,0 %

recycled/ reused, in which application?	8. Energy (biomass, biogas…)	50,0 %
Do you have to pay or charge for its management?	9. Cost	33,0 %
	10. Income	33,0 %
	11. No cost-no income	33,0 %

The main conclusions obtained from the table are that by-product generation can be very different depending on the type of winery (small industry or several wineries associated to a cooperative) from 100 tn/y to almost 50000 tn/year), which could affect to the specific hurdles and bottlenecks in each case.

Seasonality is another key aspect, as the by-product generation in 66 % of the cases is in less than3 months. This implies the need to valorise or stabilise the entire quantity produced in a short period of time in order to avoid deterioration.

In 66 % of the situations, they valorise them in the food and energy industry. The other 33 % manage the by-products as waste. In addition, only 1/3 has an income from the valorisation process. The others have cost or no income.

The main problems related to the management of by products are by-products storage and transport, followed by by-product processing and separation in the production lines and to a lesser extent commercialization of new products. They identify also other specific problems such as: Handling of by-product, lack of specific protocols and training of by-product handlers (farmers/livestock farmers).

They have selected which are the main problems they face at each point of the food chain.

The main problems related to the processing of by-products are:

- Lack of technologies to process them correctly
- High inversion cost of the existing technologies
- Some by-products contain substances that limit their use for example in animal feed

The main problems related to the Transport are:

- Lack of trucks and vans
- High energy cost
- Multi-product transport: difficulties in avoiding cross-contamination between by-products

The main problems related to the Storage are:

- Limited by-product shelf life due to high humidity content
- Space limitations
- Lack of refrigeration facilities and need for specific spaces

The main problems related to the commercialization are:

- Absence of real alternatives of value
- Lack of knowledge of market possibilities

One of the main concerns is that the value proposition of a by-product does not equal/improve the current option, for example, the incorporation of a by-product as a substitute for other sources of protein/fibre in animal feed, most of the time implies preparation and storage conditions that make its value more expensive,

making its incorporation in the animal diet unfeasible. In addition, sometimes the effects of its inclusion in the diet imply production losses, given that current diets are clearly more optimised to achieve maximum production yields.

They will be interested in obtaining a technological solution for their by-product valorisation as ingredient for animal feed because they want to:

- Add value to the by-products generated in the winery
- Promote the culture of circular economy and bioeconomy in the Cooperative.
- Assume responsibility for the sustainable use of the waste generated.
- Diversify their products.
- Have an economic benefit

They are interested in obtaining specific solutions for their companies. The main reasons are:

- Eliminate the internal management of the by-product
- Collaborate with other entities
- Participate in collaborative networks
- Evaluate the incorporation of a specific solution adapted to our needs.

As additional information they would like to know different valorisation options for their by-products.

3.2.2 Logistic & processing

A total of 2 responses from the logistic and processing industry were analysed. One of them processes used vegetable oil and coffee grounds and the other fish by-products and both companies process more than 1000 tons/y of by-products.

The main problems related to the collection or recovering by-products as a raw material is the by-product processing and transport, followed by by-product storage and to a lesser extent commercialization of new products and separation in the production lines.

They have selected which are the main problems they face at each point of the food value chain.

The main problems related to the separation of the by-products are:

- Mixture with other by-products
- Absence of protocols for the separation

The main problems related to the s**torage** of the by-products are:

- Limited by-product shelf life
- Absence of refrigeration facilities

The main problems related to the **transportation** of the by-products are:

- Long distances to the processing plant
- High cost of energy
- Multi-product transport: difficulties to avoid cross contamination

The main problems related to the **processing** of the by-products are:

- High investment cost
- Absence of technologies

The main problems related to the **commercialization** of the by-products are:

- Lack of market knowledge

They have expressed their interest in **a technological solution** for their by-product valorisation as ingredient for animal feed. Their main interests are focused on:

- Expanding markets for by-products that are already exploited currently, and open markets for by-products with potential that are not used currently.
- Assessing other innovative technologies against the current one.

Finally, they are interest in **a specific solution** for their companies because they want to:

- Expand markets and commercial outlets for by-products that they currently handle.
- Evaluate other technological/commercial alternatives for their by-products.

3.2.3 Feed industry

A total of 3 responses from the feed industry were analysed. In the table 4, we summarize some of the answers related to by-product integration in their formulas.

Table 4. *Analysis of Feed industries responses to questions*

Question	Answer	Gravity factor/hurdle
Do you currently include any organic by-product as an ingredient in the formulation?	1. Yes	66 %
	2. No	33 %
If yes, what amount?	3. 5-10 %	100 %
If yes, what by-product is it and why?	4. Bran, beet and orange pulp, molasses... to make the formulation cheaper. We will study any other by-product of potential interest in animal feed.	50 %
	5. Biscuit flour for feed cost reduction effect	50 %
If no, what is the reason?	6. Lack of continuous availability over time. Apprehension of the partners to the incorporation of new products, which may modify the characteristics of the resulting meat (colour, smell, etc.).	100 %

if no, would you include a new ingredient produced from organic by-products in your formulations if it was competitive?	7. Yes	100 %

The main conclusions obtained from the table are that by-products integration in the feeding formula is becoming more and more widespread mainly due to an interest in reducing costs. Examples of by-products that are already included in feed formulas are bran, beet and orange pulp, molasses, and biscuit flour. However, the inclusion level is still low between 5 and 10 %.

The main reasons for not including by-products in feed formulations are the lack of continuous availability over time and the apprehension of the partners to the incorporation of new products, which may modify the characteristics of the resulting meat (colour, smell, etc.).

The key aspects to increase by-products inclusion could be to guarantee continuous availability over time, thus, a competitive technology to stabilize the by-products must be selected and to increase the percentage of inclusion to guarantee the new ingredient market.

The main aspects to consider when including a new ingredient in the formulations is the price of the by-product, followed by the guarantees of supply and the nutritional value of the new ingredient. To a lesser extent feed industry also considers important origin and traceability of the by-products, consumer acceptance and food safety. Finally, as a less important factor we find the sustainability.

Other hurdles that they have identified are the handling of the by-products in the factory and the effect of the inclusion of new by-products could have in the morphology of the resulting meat, such as, changes in colour, odour, or taste.

They have selected which are the main requirements related to different affecting factors.

In relation to **Price**, their main requirements are:

- Cheaper ingredient than current raw materials

In relation to **Nutritional value**, their main requirements are:

- A source of fat
- A source of protein

In relation to **Supply guaranties**, their main requirements are:

- Short-term commercial supply agreement (< 2 years)
- Specific agreements (< 1 years)

In relation to **Sustainability**, their main requirements are:

- New raw materials with less environmental impact
- Less impact of the production process

In relation to **Food safe**, their main requirements are:

- Compliance with the law
- Full control of hygienic parameters (beyond legal requirements)

In relation to **Origin / Traceability**, their main requirements are:

- Compliance with the law

In relation to **Consumer acceptance**, their main requirements concerns are:

- Low consumer acceptance due to the use of by-products
- High consumer acceptance due to environmental care
- Possible impact on the quality of the final product (pig, calves and foals, and eggs)

All of them answer that they would include **enriched ingredients** such as antioxidants, immunostimulatory, etc. if they would add value to the final feed because it could add value to the feed and differentiation with other feed producers. They also argue that it could help to reduce medicine consumption and to increase meat shelf life.

In the case they obtain above mentioned benefits they manifest that they would be willing to pay an extra cost for the new ingredient.

3.2.4 Livestock

A total of 2 responses from the livestock were analysed. In the table 5, we summarize some of the answers related to by-product integration in their formulas.

Table 5. *Analysis of Livestock industries responses to questions*

Question	Answer	Gravity factor/hurdle
Do you currently include any organic by-product as an ingredient in the formulation?	1. No	100 %
If no, what is the reason?	2. I use little feed, I don't know if it has organic by-products	50 %
	3. I don't know if it has by-products	50 %
if no, would you include a new ingredient produced from organic by-products in your formulations if it was competitive?	4. Yes	100 %

The main conclusions obtained from the table are that by-products' inclusion or not in feed formulations is not something that is managed at the farm level but rather by the feed formulation industry.

The main aspects to consider when including a new ingredient in the formulations are the price of the by-product, the nutritional value and the consumer acceptance, followed by the guarantees of supply and the food safety. To a less extent they also consider important origin and traceability of the by-products. Finally, as a less important factor we find the sustainability, like happens in the feed industry.

They have selected which are the main requirements related to different affecting factors.

In relation to **Price**, their main requirements are:

- Cheaper than current raw materials
- Same price than current raw materials
- I don´t mind the price if the ingredient is good enough

In relation to **Nutritional value**, their main requirements are:

- A source of Protein
- A source of Fat
- Immunostimulatory properties

In relation to **Supply guaranties**, their main requirements are:

- Short-term commercial supply agreement (< 2 years)
- Specific agreements (< 1 years)

In relation to **Sustainability**, their main requirements are:

- New raw materials with less environmental impact

In relation to **Food safe**, their main requirements are:

- Compliance with the law

In relation to **Origin / Traceability**, their main requirements are:

- Compliance with the law
- Full control of Origin / Traceability (beyond that defined by law)

In relation to **Consumer acceptance**, their main concerns are:

- Low consumer acceptance due to the use of by-products
- High consumer acceptance due to environmental care

All of them answer that they would include enri**ched ingredients** such as antioxidants, immunostimulatory, etc. if they would add value to the final feed because it could add value to the final product. In the case they obtain above mentioned benefits the 50 % would pay an extra cost but the other 50 % wouldn't.

3.3 Success stories

Livestock products are projected to increase up to by 70 % by 2050. Many of the ingredients in the diets of EU livestock are sourced from imported raw materials from the Americas: mainly soybeans, etc. This deficit presents already a risk to social, economic and environmental progress in Europe due to the increasing scarcity of global resources. Hence, the inclusion of biowaste in animal feed is necessary to lead to additional benefits for animal feed sector: availability of environmentally friendly ingredient sources and decrease of dependence on foreign sources.

Research on animal feed has often been focused on finding alternative feed ingredients to replace edible ones in order to reduce feed costs and reduce competition with human consumption. In addition, in recent years with the aim of promoting the circular economy, the use of agro-industrial by-products as feed resources has been prompted bringing benefits both for the economy and for the environment. In this context, there have been studies on the potential use of grape marc as a feed source for ruminants. Grape marc is the primary wine coproduct consisting primarily of grape seeds and skins. Grape pomace is currently predominantly disposed of through composting or utilized as an economical livestock feed. The use of by-

products in animal feed is hindered by several factors, including significant fluctuations in moisture content, nutrient levels, and bioactive compounds. These variations are often associated to seasonal production patterns. Additionally, the associated costs of transportation and storage further restrict the widespread utilization of these by-products as common ingredients in animal feed formulations. In addition, it possesses significant potential for value-added applications. Both white and red grape pomaces are rich in indigestible fiber, comprising polysaccharides and oligosaccharides, as well as phenolic compounds, known for their antioxidant properties and more. Recently, there has been growing interest in exploring the potential health benefits of grape pomace, particularly concerning its phenolic content and its broader impact on the gut microbiome.

In a similar way to grape pomace, grape stems contain many nutrients that are currently underutilized. The composition of the grape stems can also vary between different grape varieties, climate, harvesting systems... Most of the sugar present is due to the pieces of grapes that are not removed during destemming. In addition, like grape pomace, they contain a high content of polyphenols that can be of great interest in modulating the ruminal microbiota and thus improving the metabolic pathways of ruminal bacteria, making them more efficient. However, most of the valorisation works found are associated with the extraction of phenolic compounds or sugars, and do not take into account zero waste processing and animal feeding purposes. These are some of the studies found in the literature:

1. Ruiz-Moreno, M.J.; Raposo, R.; Cayuela, J.M.; Zafrilla, P.; Piñeiro, Z.; Moreno-Rojas, J.M.; Mulero, J.; Puertas, B.; Giron, F.; Guerrero, R.F.; et al. Valorization of grape stems. Industrial Crops and Products 2015, 63, 152-157, doi:https://doi.org/10.1016/j.indcrop.2014.10.016.

2. Gouvinhas, I.; Santos, R.A.; Queiroz, M.; Leal, C.; Saavedra, M.J.; Domínguez-Perles, R.; Rodrigues, M.; Barros, A.I.R.N.A. Monitoring the antioxidant and antimicrobial power of grape (Vitis vinifera L.) stems phenolics over long-term storage. Industrial Crops and Products 2018, 126, 83-91, doi:https://doi.org/10.1016/j.indcrop.2018.10.006.

3. Bzainia, A.; Dias, R.C.S.; Costa, M.R.P.F.N. A simple process to purify I-resveratrol from grape stems with a photo-molecularly imprinted sorbent. Food and Bioproducts Processing 2023, 142, 1-16, doi:https://doi.org/10.1016/j.fbp.2023.08.010.

4. Leal, C.; Gouvinhas, I.; Santos, R.A.; Rosa, E.; Silva, A.M.; Saavedra, M.J.; Barros, A.I.R.N.A. Potential application of grape (Vitis vinifera L.) stem extracts in the cosmetic and pharmaceutical industries: Valorization of a by-product. Industrial Crops and Products 2020, 154, 112675, doi:https://doi.org/10.1016/j.indcrop.2020.112675.

In a recent search that we have made, we have also found the first reference of grape stem valorization for using it as animal feed. This research uses solid state fermentation to assess the potential of three fungi strains to degrade lignin and enhance the nutritive value of grape stems.

5. Costa-Silva, V.; Anunciação, M.; Andrade, E.; Fernandes, L.; Costa, A.; Fraga, I.; Barros, A.; Marques, G.; Ferreira, L.; Rodrigues, M. Biovalorization of Grape Stalks as Animal Feed by Solid State Fermentation Using White-Rot Fungi. Applied Sciences 2022, 12, 6800.

They concluded that the incubation for 42 days of grape stem in solid state fermentation decreased the lignocellulosic biomass an increased the protein content and the in vitro organic matter digestibility. This study was only carried out with in vitro trials and not with in vivo as our research, and it was published in 2022, after the start of our project. Therefore, these are overlapping initiatives from which new complementary studies may emerge.

In conclusion, the use of grape stems as animal feed is a field under study. Although it has limitations such as its high organic content and its high amount of fiber, which makes it a material with lower digestibility than other by-products, we believe that it can be valorised and used in inclusion percentages of 10%, providing functional compounds to animal diets and reducing the need to import cereals from other countries. In addition, in this TRl6-7 project, we will work on the items of collection, handling and processing on a pilot scale, analysing their technical, economic, and environmental feasibility.

4. Case study 2 - Orange peels value chain

4.1 Chemical composition

The average composition of orange peels by-product coming from orange juice production industries is presented in the table below (Table 6).

Table 6. Composition of orange peels by-product coming from orange juice production industries (% d.b.)

Component	Mean	Minimum	Maximum	SD
Ash	4.90	3.0	20.3	2.88
Crude protein	7.12	5.12	11.2	1.2
Ether extract	3.05	1.0	8.3	1.4
Crude fibre	12.3	6,4	28.6	3.98
Neutral detergent fibre	22.6	11.8	43.1	5.8
Acid detergent fibre	13.9	8.3	23.2	3.0
Acid detergent lignin	1.21	0.34	5.18	0.72
Hemicellulose	8.70	3.0	24.8	4.0
Cellulose	12.7	7.4	18.2	2.7
Total dietary fibre	43.9	22.3	70	9.2
Soluble fibre	21.3	6.8	42.2	6.8
Neutral detergent insoluble crude protein	1.31	0.31	2.9	0.64
Acid detergent insoluble crude protein	0.42	0	1.07	0.24
Neutral detergent insoluble nitrogen	0.21	0.05	0.46	0.10
Acid detergent insoluble nitrogen	0.07	0.00	0.17	0.04
Sugars	40.8	17.6	64.9	10.5

Orange peels, like other agricultural products, can be subject to a range of potential contaminants, including bacteria, molds, and pesticides. As far as bacteria are concerned, potentially harmful bacteria such as E. coli, Salmonella, Listeria, and others can contaminate orange peels through contact with contaminated water, soil, or handling. Spoilage bacteria can also cause spoilage and affect the quality of orange peels by producing off-flavors, odors, or physical changes. Molds such as *Aspergillus* which is a common mold that can produce mycotoxins, harmful to humans may also grow on orange peels. Another common mold that can affect the

quality and safety of orange peels is Penicillium. Alternaria is also a mold that can produce mycotoxins and is a potential contaminant in orange peels.

On the other hand, pesticides used in citrus cultivation may leave residues on the fruit and peels. These residues can include insecticides, fungicides, and herbicides. In some cases, illegal or unapproved pesticides might be used, posing additional risks. Thus, to ensure the safety and quality of orange peels, it's important to take measures to prevent or mitigate the presence of these contaminants, including:

- Good Agricultural Practices (GAP): Employing proper farming practices to reduce the risk of contamination during cultivation, including safe pesticide use, hygiene, and water quality control.
- Proper Harvesting and Handling: Ensuring that the orange peels are harvested, handled, and transported in a way that minimizes contact with contaminants.
- Storage Conditions: Proper storage of orange peels at the right temperature and humidity levels can help prevent mold growth and bacterial contamination.
- Pesticide Monitoring: Regular testing for pesticide residues to ensure they are within regulatory limits.
- Microbiological Testing: Regular testing for bacterial and mold contamination to ensure the safety and quality of the peels.
- Hygiene and Sanitization: Implementing hygiene and sanitation protocols during processing and packaging to prevent contamination.
- Quality Control: Monitoring for physical signs of contamination, such as mold growth, off-odors, or spoilage, during processing and storage.
- Regular monitoring and testing, along with adherence to food safety regulations and guidelines, are essential to address and mitigate the presence of contaminants in orange peels intended for processing or consumption.

Table 7 shows the information related to the potential hazards of grape stem raw material.

Table 7. Orange peel hazards composition.

Parameters	Units	Detection limit	Results
Nitrates	mg / kg	< 10	< 10
Nitrites	mg / kg	< 10	< 10
Pb	mg / kg		0.0171
Cd	mg / kg		0.0005
As	mg / kg		0.0058
Hg	mg / kg		<0.05
Aerobic mesophiles	ufc / g		1.1×10^3
Escherichia coli	ufc / g		$< 10^2$
Salmonella	/ 25g		Absence
Staphylococcus aureus	ufc / g		$< 10^2$
Enterobacteria	ufc / g		< 10

Coliforms	ufc / g		$<10^2$
Clostridium perfringes	ufc / g		< 10
Listeria	/ 25g		Absence
Molds	ufc / g		3.5×10^3
Yeast	ufc / g		3.0×10^2
Aflatoxin B1	µg / kg	0.5	< 0.5
Aflatoxin B2			< 0.5
Aflatoxin G1			< 0.5
Aflatoxin G2			< 0.5
Zearalenona	µg / kg	5,0	< 5.0
Deoxynivalenol (Vomitoxina)	µg / kg	50	< 50
Ocratoxin A	µg / kg	0.3	< 0.3
Fumonisin B1	µg / kg	50	< 50
Fumonisin B2	µg / kg	50	< 50
T-2	µg / kg	50	< 50
HT-2	µg / kg	50	< 50
Aldrin	mg / kg	0.01	< 0.01
Chlordane	mg / kg	0.01	<0.01
DDT	mg / kg	0.01	< 0.01
Endosulfan	mg / kg	0.01	< 0.01
Endrin	mg / kg	0.01	< 0.01
HCH	mg / kg	0.01	< 0.01
Heptachlor	mg / kg	0.01	< 0.01
Hexachlorobezene	mg / kg	0.01	< 0.01

4.2 Hurdles and Bottlenecks identified

The value chain consists of the use of orange peel from the orange juice industry to produce an improved ingredient for ruminants (dairy sheep). Primary activities of the orange peel value chain consist of six main components and are all essential for adding value and creating competitive advantage to the new advanced feedstuff. The six components of the value chain of orange peels are the following:

- ✓ **Raw material:** In our case the secondary raw material producer is mainly the orange juice industry.
- ✓ **Inbound logistics** include functions like receiving, warehousing, managing inventory and respective transportations.
- ✓ **Operations** include the procedures for converting orange peels into finished product -dairy sheep feedstuff and these procedures will be defined in WP2 and WP3.
- ✓ **Outbound logistics** include activities to distribute the final product to a consumer.
- ✓ **Marketing and sales** include strategies to enhance visibility and target appropriate customers—such as advertising, promotion, and pricing.
- ✓ **The End-users** that are mainly Animal feed companies, Animal feed distributors, Farmers and Sheep products consumers.

The methodology for the identification of the hurdles and bottlenecks that targets to the value chain of orange peels involves the following steps that are thoroughly analysed in the following sections:

- ➢ The production of a **List of main stakeholders** classified according to the value chain as Raw material producers and End-users, orange juice industries, animal feed producing and distribution companies and farmer associations.
- ➢ The distribution of a questionnaire comprised of the questions that have been referred in Section 2 of this present Deliverable to the stakeholders identified within the previous step.
- ➢ The conduction of interviews and detailed questionnaires to selected stakeholders of the industries involved. NTUA team will communicate with the selected crucial actors of the value chain and record their feedback on the current situation, as well as their perspective on the new valorisation route.
- ➢ The description of success stories such as orange-peel silage. This product's value chain will be analysed and possible risks of the NEWFEED case of orange peels will be enlightened.

More specifically, the identification of hurdles and bottlenecks for the case of orange peel value chain will follow the above-mentioned steps:

- ➢ A small description of the respective sector and market in the direction of highlighting the size of the respective sector
- ➢ A summative and critical presentation of the hurdles and bottlenecks, derived from the answers obtained at the respectively sent questionnaires, along with a gravity factor, namely the relative percentage within the obtained answers and a more detailed discussion on the results.
- ➢ A brief presentation of the success stories towards the valorisation of by-products that are used in animal feed.

4.2.1 Food industry

Orange juice production chain includes growers, fruit processors, juice packers and retailers. Orange processors take in fruit and process it to produce concentrate juice and NFC '**Not from Concentrate**' juice also called single strength juice. The term "Single-strength Juice" assigned to juice at its natural strength, either directly from the extraction process or in a reconstituted form. A "Concentrated Juice" is a product that has been concentrated by the removal of water in a sufficient amount to increase the °Brix level to a value of at least 50 % greater than the °Brix value established for reconstituted juice from the same fruit.

Orange processors can be divided into two groups marketing processors and bulk processors. Marketing processors sell packaged juice under their own brand name, which requires retail and consumer marketing skills. Bulk processors mainly sell their products in bulk form, which requires skills in the efficient distribution and marketing of a commodity.

Orange processors are producing the juice and orange peels as their main solid waste. From an industrial point of view an orange can be considered as a composite of 43 % juice and 57 % peel and pulp. Thus, for single-strength juice 1,33 kg peels are produced per litre of juice, while the respective value for concentrated juice is over 2,85 kg/L.

According to latest FAO statistical data (2019), the geographical distribution of juice production and the respective peels production are presented in Figure 3. The potential of peels production is over 8 million tons globally and nearly 600 000 tn in Europe.

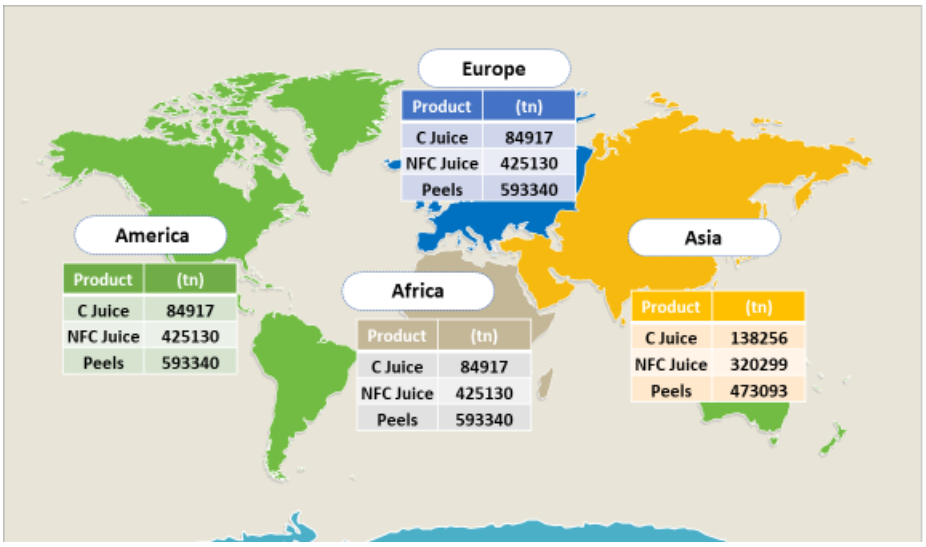
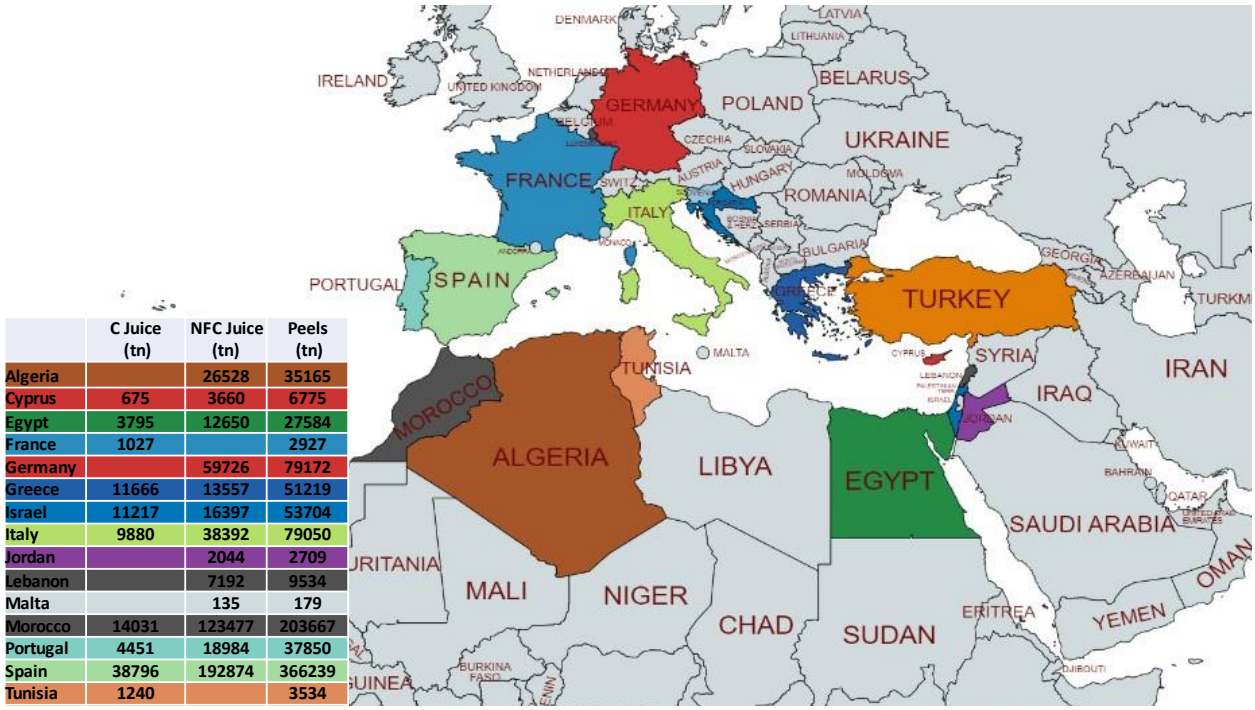


***Figure 3**. Geographical distribution of annual production of orange juice production and resulting orange peels (2019)*

Focusing on the Prima Mediterranean countries, the respective data are presented in Figure 4. In total, 963 285 tn of orange peels have been produced in 2019. The highest contribution comes from **Spain 38,02 %**, followed by Morocco 21,14 %, while **Greece** contribution amounts to **5,32 %.** In the case of Greece, the orange juice production for 2019 accounts to 25 223 tonnes, highlighting the size of Greek orange juice production market and the great absorbance potential of orange peel as an alternative feed ingredient. The estimated orange peels produced were 51 219 tonnes. According to the Greek Statistic Authority, the orange juice production companies account to 22.



	C Juice (tn)	NFC Juice (tn)	Peels (tn)
Algeria		26528	35165
Cyprus	675	3660	6775
Egypt	3795	12650	27584
France	1027		2927
Germany		59726	79172
Greece	11666	13557	51219
Israel	11217	16397	53704
Italy	9880	38392	79050
Jordan		2044	2709
Lebanon		7192	9534
Malta		135	179
Morocco	14031	123477	203667
Portugal	4451	18984	37850
Spain	38796	192874	366239
Tunisia	1240		3534

Figure 4. *Orange Juice production and resulting peels availability in Prima Mediterranean countries (2019)*

In the fruit juice production sector, there is a strong concentration, as a result of the dominance of two large companies in it. However, it is important that other small and medium-sized companies operate in the Greek market, with a national or local sales network. According to the available data, 22 companies are active in the juice sector across Greece, with a total turnover of € 193,9 million. Based on the total volume of sales, in the first place is the prefecture of Argolis with € 67,5 million, followed by the prefecture of Attica with € 8,2 million less. NTUA NEWFEED team tried to communicate with all the Greek orange juice producing companies with various ways, such as phone communication and email communication.

The questionnaires distributed to orange juice production companies, include the questions, as already has been presented in Section 2. The answers received were only six, but still provide some valuable feedback regarding the hurdles and bottlenecks of the orange peel value chain. Moreover, the answers received provide a general guideline for the NEWFEED project team in relation to the stakeholder's requirements, for the incorporation of orange peel in feed products.

Prior to the discussion of the hurdles and bottlenecks, it is worth bearing in mind the source of information coming from small size orange juice companies that consider orange peels as a secondary resource promoting them as animal feed. This profile is evident from the analysis of the received answers as presented in the following Table (Table 8).

Table 8. *Analysis of Orange juice industries responses to questions*

Question	Answer	Gravity factor/hurdle
What quantity of organic by-products do you produce?	12. 1000-10000 tn/y	83,5 %
	13. 10000-50000 tn/y	16,7 %
	14. Valorisation/Recycling	66,6 %
	15. Fresh feed	16,7 %

What is the current management of your organic by-products?	16. Orange peel is sold to livestock farmers without any treatment	16,7 %
If it is valorised/ recycled/ reused, in which application?	17. Animal feed	100 %

The highest percentage, 83,5 %, of the orange juice industries generate per year between 1 000 and 10 000 tonnes of by-product per year, while 16,7 % of them generate between 10 000 and 50 000 tonnes. **The quantities stress out the need for valorisation of the by-product.** The highest percentage of the producers also states that they currently valorise/recycle their by-product, while all of them state that they valorise their by-product towards animal feed production. In view of these responses, it can be concluded that the valorisation pathway of orange peels towards animal feed is existing in the practices of industry and thus the NEWFEED innovation could build on this.

Nevertheless, two concrete hurdles result from the answers that the companies have provided, as shown at the following Table (Table 9).

Table 9. *Analysis of answers of orange juice food industries*

Question	**Answer-Hurdle**		**Gravity factor/hurdle**
Is the generation of your organic by-products seasonable?	1.	< 3 months/year	16,6 %
		< 6 months/year	16,6 %
		< 9 months/year	50,2 %
Which are your main problems that you face in the management of the by-product?	2. Separate collection of organic by-products within the production line		16,7 %
	3. Storage of by-products		83,3 %

In view of these responses, the two main hurdles and bottlenecks are the **seasonality** of the raw material and the problems regarding the **management of by-product**. The generation of the raw material is seasonal for the 73,4 % in total of the industries that have replied, while as main problems for the management, the "Storage of by-products" is the most significant, with a gravity factor equal to 83,3 %, followed by "Separate collection of organic by-products within the production line" with the respective factor being equal to 16,7 %.

Further analysis of the received responses (Table 10) could enlighten and map the specific difficulties that companies face in the management and valorisation of orange peels. Additionally, it is worth mentioning that one orange juice producer pointed out the use of Ensiling Technique, as a successful management strategy of orange peels that will be analysed at Section 3.2.4.

Table 10. *Analysis of responses in questions 2-9*

Question	Answer-Hurdle	Gravity factor/hurdle
In relation to Separate Collection, which are your main problems?	1. Space Limitations	50,0 %
	2. Mixture with other by-products	33,3 %
	3. Personnel limitations	16,7
In relation to Storage, which are your main problems?	4. Limited by-product shelf life	40,0 %
	5. Space Limitations	40,0 %
	6. Absence of refrigeration facilities	20,0 %
In relation to Transportation, which are your main problems?	7. Absence of own trucks or vans	25,0 %
	8. Long distances to processing plant	25,0 %
	9. High cost of energy	25,0 %
	10. Multi-product transport: difficulties to avoid cross contamination	25,0 %
In relation to Processing, which are your main problems?	11. Absence of technologies	40,0 %
	12. High investment cost	40,0 %
	13. High energy cost	20,0 %
In relation to Commercialization, which are your main problems?	14. Lack of market knowledge	40,0 %
	15. The by-product has no value	40,0 %

The most significant problems that the orange juice industries face in relation to **Separate Collection** are the **Space Limitations**, with a gravity factor equal to 50,0 %, followed by the fact that the by-product is **mixed with other products** (gravity factor: 33,3 %) and **Personnel limitations** (gravity factor: 16,7 %)

The most significant problems that the orange juice industries face in relation to **Storage** are both the **Limited by-product shelf-life** and the **Space Limitations**, with equal gravity factors of 40,0 %, followed by the **Absence of refrigeration Facilities** with a gravity factor equal to 20,0 %.

The most significant problems that the orange juice industries face in relation to **Transportation** are the **Absence of own trucks or vans**, the **long distances to processing plant**, the **High cost of energy** and the **multi-product transport: difficulties to avoid cross contamination**, with equal gravity factors of 25,0 %.

The most significant problems that the orange juice industries face in relation to **Processing** are both the **Absence of technologies** and the **High investment cost**, with equal gravity factors of 40,0 %, followed by the **High energy cost** with a gravity factor equal to 20,0 %.

Finally, the most significant problems that the orange juice industries face in relation to **Commercialization** are both the **Lack of market knowledge** and the fact that the **by-product has no value**, with equal gravity factors of 40,0 %.

These issues should be considered during NEWFEED implementation. All orange juice industries are **interested** in a technology solution to valorise their organic by-products for animal feed and 83,3 % of them would like the **NEWFEED** to provide them a tailored treatment solution for their company.

4.2.2 Animal Feed industry

Ruminant feed is the fodder that is blended from various raw materials and additives. These blends are formulated according to the specific requirements of the target animal. They are manufactured by feed compounders as meal type, pellets, or crumbles. The Global Ruminant Feed Market is segmented by Animal Type (Dairy Cattle, Beef Cattle, and Other Animal Types), Ingredient Type (Cereals, Cakes and Meals, Food Wastages, Feed Additives, and Other Ingredients), and Geography (North America, Europe, Asia-Pacific, South America, and Middle East & Africa). The global ruminant feed market is poised to register a CAGR of 3,2 %.

In response to globalization and the rising demand for animal-sourced foods, the global ruminant sector attained strong growth in the past couple of years, in both developed and developing nations. This, in turn, has paved a significant opportunity for the manufacturers to increase the ruminant feed production, to optimize the production in a sustainable manner and meet the burgeoning demand from both the meat and dairy industries from different countries around the world. The United Nations Food and Agriculture Organization (FAO) estimates that the demand for food will grow by 60 % between 2010 and 2050. Furthermore, it is also estimated that the production of animal proteins is expected to grow by around 1,7 % per year, with meat production projected to rise by nearly 70 % and dairy by 55 %. Farmers are relying on feed to obtain high performance and quick weight gain in animals over a short period of time. To satisfy the demand for the meat processing industry, livestock farmers need to produce high-quality and hygienic meat, which is a big challenge. Therefore, this, in turn, may increase the consumption of ruminant feed. The major driving factor for the growth of the market is the increasing trend of on-farm mixing by small farmers, millers, and livestock manufacturers to provide specific nutrients to ruminants in the required quantities. The **major drivers** of the ruminant feed market are:

- increasing demand for high-value animal protein,
- increased awareness regarding the safety of meat and milk products, and
- increased industrial livestock production.

On the other hand, the **major restraints** are the **rising cost of raw materials** and **government regulations.** Additionally, consumers across the world are opting for animal-sourced products, such as meat, milk, and other products, that are obtained from organically raised animals. This has resulted in increased sales of organic food products, including dairy and meat products, across the world. This rising demand for organically sourced meat and dairy products may restrain the growth of the compound feed market.

The growing global population, increasing per capita global consumption of meat, and the increasing adoption of intensive farming methods are the major factors driving the demand for ruminant feed. The global ruminant feed market is presented in Figure 5. Europe is a matured market for ruminant feed, in terms of consumption. In the region, ruminant feed has long been used as productivity enhancers in livestock. Therefore, the regional market is modern and highly regulated, especially in Western Europe. The major countries in the market are Spain and Germany.

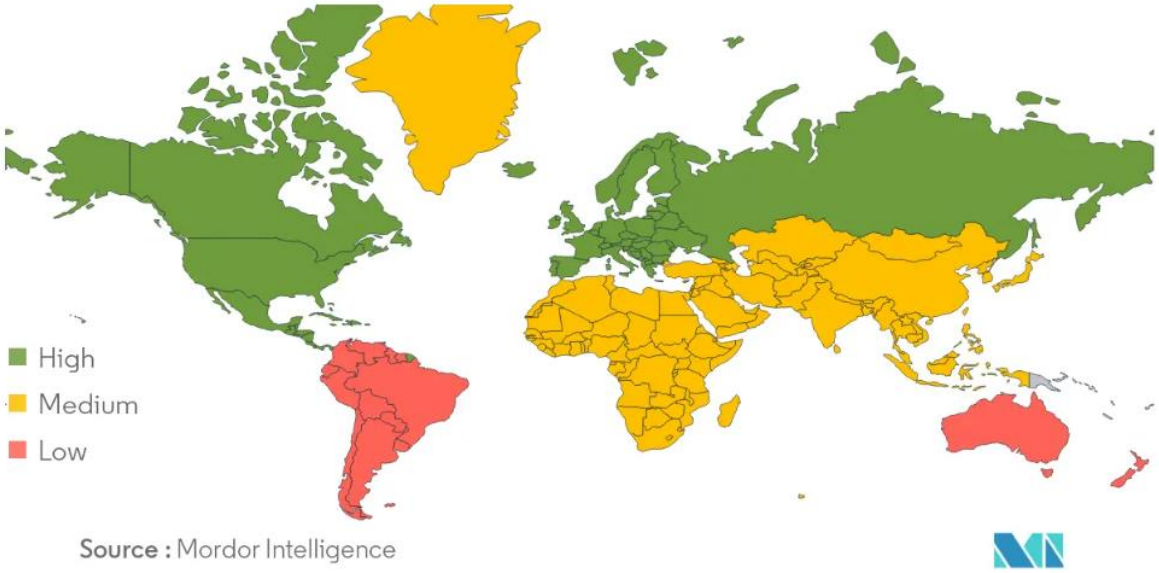


***Figure 5**. Global Ruminant Feed Market, market size by region (2019)*

The global ruminant feed market is fragmented with some feed manufacturers, while the rest of the market is divided among small companies, mostly feed mills. Around 94 % of the market share is occupied by feed mills, while the top five companies (Cargill Inc., Land O Lakes Feed, De Heus, Archer Daniels Midland, For Farmers) account for 6 % of the remaining share [https://www.mordorintelligence.com/industry-reports/global-ruminant-feed-market-industry].

In the case of Greece, according to the National Statistical Service, the animal feed production market for 2019 is presented in Table 11, highlighting the size of Greek animal feed production market and the great potential of orange peel as an alternative feed ingredient.

Table 11. *Animal feed production statistical data (2019)*

Product description	Number of Companies	Production quantity (tn)	Sale Quantity (tn)	Value Sold (€)	Average Price (€/kg)	Average Price EU 28 (4.8.2020)
Premixes for animal feed	16	107334	103899	28 769 935	0,2769	0,556
Animal feed for use (excluding premixes): pigs	45	74234	50429	21 143 717	0,4193	0,277
Animal feed for use (excluding premixes): bovine animals	42	86774	85430	28 830 641	0,3375	0,303
Animal feed for use (excluding premixes): poultry	51	683700	637437	242 002 421	0,3796	0,305

Animal feed for use (excluding premixes): other	28	457128	331010	255 977 710	0,7733	0,400

NTUA project team set up a list of 67 companies including animal feed companies and the animal feed distributing companies as well. The questionnaires distributed to animal feed production and distributing companies, include the questions presented in Section 2.

The answers received were only five, but still provide some valuable feedback regarding the hurdles and bottlenecks of the orange peel value chain. Moreover, the answers received provide a general guideline for the NEWFEED project team in relation to the stakeholder's requirements, in order for the incorporation of orange peel in feed products.

The analysis of the received responses as presented in the Table 12 could highlight the main hurdles.

Table 12. *Analysis of question*

Question	**Answer-Hurdle**	**Gravity factor/hurdle**
Do you currently include any organic by-product as an ingredient in the formulation?	No	60,0 %
What is the reason, for which you don' t currently include any organic by-product as an ingredient in your formulation?	It is hard for a new ingredient to be incorporated in feed and this is due to the operation of the industrial equipment	50,0 %
	It has not been requested by customers	50,0 %
If you don' t currently include organic by-product as an ingredient in your formulation, would you be interested to do so?	No	25,0 %
In relation to consumer acceptance, what would be your concerns?	Small acceptance due to the fact that the raw material is derived from food waste	66,7 %

A significant percentage of feed producers equal to 60 % doesn't currently include any organic by-product as an ingredient in their formulation. The main reason pointed out are the facts that the incorporation of a new ingredient requires new equipment (50 %) and that this is out of customers' requests (50,0 %).

Moreover, a percentage of 25 % is not interested to incorporate new ingredients in their existing formulations. The latter along with the limited responses received shall also be considered as a hurdle. The feed producers, in a percentage equal to 66,7 %, expressed their concern that the new feed will not be much accepted by consumers, on the basis that the raw material is derived from food waste.

On the other hand, 40,0 % of companies include an organic by-product as an ingredient in the formulation, at a percentage between 1 to 15 %. Additionally, the companies **interested** to include an organic by-product as an ingredient in the formulation consider that the most important criteria for doing so are firstly the

nutritional value, followed by price, consumer acceptance and food safety with the same gravity factor. The criterion of origin comes next and lastly with a gravity factor of 20 % follows the criteria of supply guarantees.

In relation to **Price**, 80 % of the respondents stated that price is not a crucial parameter, if the quality of the ingredient is high, while in relation to **nutritional value,** 80 % of the respondents assess protein content of the new by-product as the most important nutritional parameter.

In relation to **Supply Guarantees**, all respondents stated that they prefer agreements into force for less than a year and in relation to Sustainability a percentage equal to 75 % stated that they would be interested in a new raw material with a smaller environmental footprint against a percentage of 25 % that stated they would be interested in the possibility of a market expansion.

Table 13. *Analysis of responses from animal feed companies*

Question	Answer-Hurdle	Gravity factor/hurdle
Do you currently include any organic by-product as an ingredient in the formulation?	1. Yes	40 %
If you currently include an organic by-product as an ingredient in your formulation, in what amount?	2. 1—15 %	100 %
If you don' t currently includes any organic by-product as an ingredient in your formulation, in what amount, would you be interested to do so?	3. Yes	50 %
	4. We have used orange peel in the past	25 %
What are the most important requirements when integrating a new ingredient in your formulations?	5. Price	60 %
	6. Nutritional value	80 %
	7. Supply guarantees	20 %
	8. Food safe	60 %
	9. Origin	40 %
	10. Consumer acceptance	60 %
In relation to price, what are your requirements?	11. Price doesn't play role, if the quality of the ingredient is fine	80 %
In relation to Nutritional Value, what are your requirements?	12. Protein source	80 %
	13. Protein source, fibre source, lipids source, easily digestible, immunostimulant	20 %

In relation to Supply Guaranties, what would you be interested in?	14. Special agreements (<1 year)	100 %
In relation to Sustainability, what you be interested in?	15. New raw material with a smaller environmental footprint	75 %
	16. Possibility of market expansion	25 %
In relation to Food Safe, what are your requirements?	17. Full control of the food safety parameters (beyond what legislation requires)	60 %
	18. Compliance with legislation	40 %
In relation to Origin, what are your requirements?	19. Full control of the food safety parameters (beyond what legislation requires)	60 %
	20. Compliance with legislation	20 %
	21. The origin of the raw material is not something that the company is concerned about	20 %
Any information you can consider interesting.	22. We use corn silage in our feed	-

4.2.3 Livestock sector

The sector of livestock refers on orange peels case study to the dairy sheep farmers. Dairy sheep are used to produce milk as the basic ingredient to a variety of specialty cheeses such as Feta and Roquefort. Other products including ice cream and yogurt are produced from sheep milk. In addition, sheep milk has lower lactose contents than ordinary milk which makes it more palatable for lactose-intolerant consumers. The use of sheep milk to produce cheese is an ancient practice developed in Europe, the Middle East, and North Africa. It is a relatively new niche industry in the United States. According to FAO 1240 million sheep (heads) were bred in 2019, while their geographical distribution is presented in Figure 6. Specific breeds of dairy sheep include British Milk sheep, East Friesian, Lacaune, and Sarda.

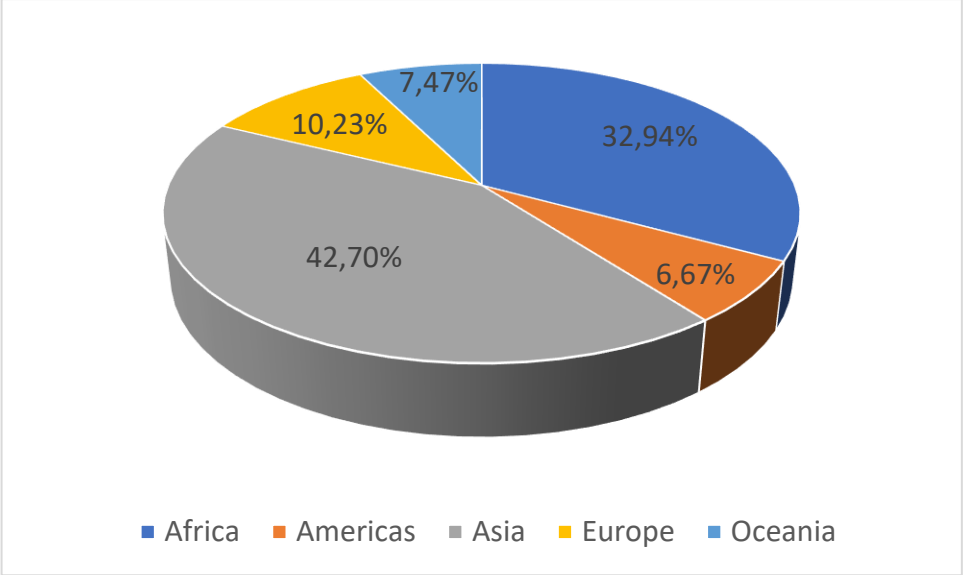


Figure 6. *Geographical distribution of number of sheep (heads) in 2019*

Sheep and goat farming plays an important economic, environmental, and social role in Mediterranean countries. Figure 7 illustrates the number of sheep in the Prima Mediterranean countries. Turkey breeds the 26 % of total population, followed by Algeria (21 %), Morocco (15 %).

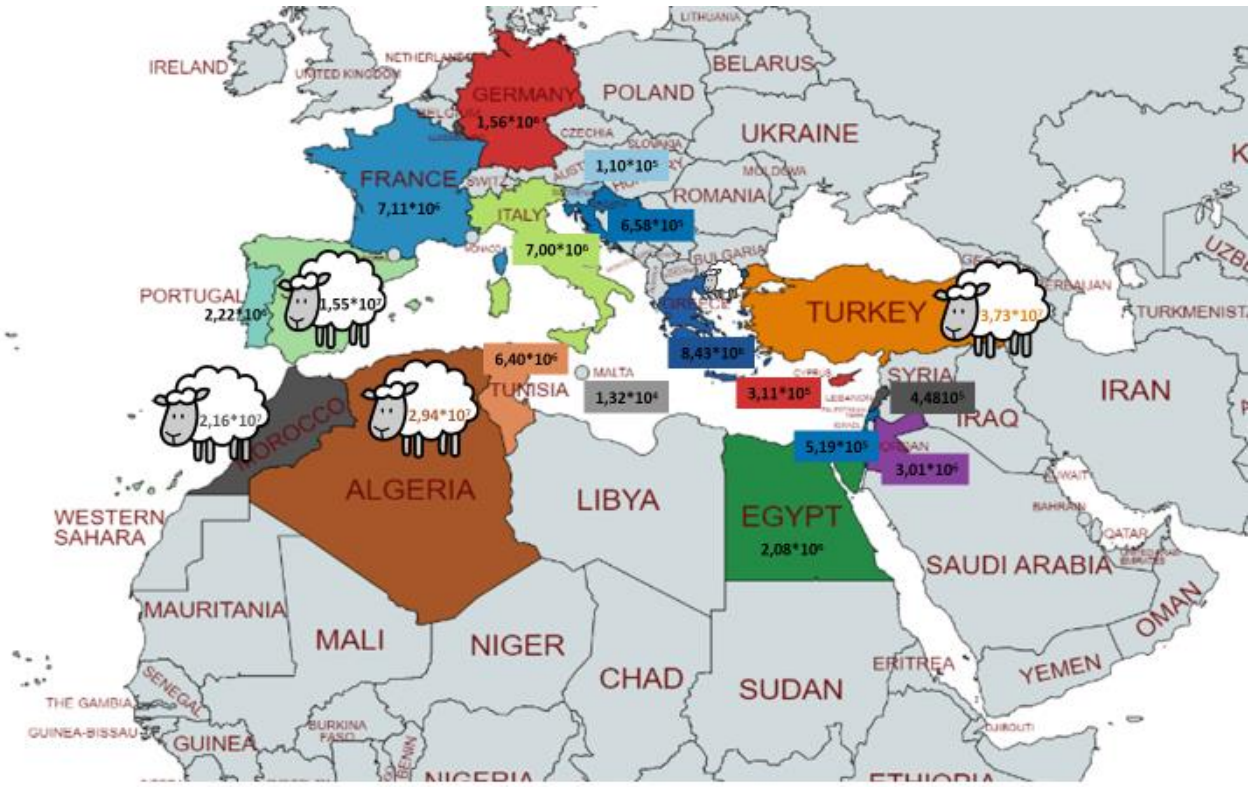


Figure 7. *Number of sheep (2019) in Prima Med countries*

In Greece, this sector can be regarded as an agricultural activity that provides a strong connection to rural, mountainous, arid, semi-mountainous, and semi-arid areas. Greece among other countries is characterized with a high proportion of mountainous areas; thus, a high percentage of the utilized agricultural area is designated as less favoured areas (LFAs). The sheep milk that is produced in Greece is mainly used for cheese manufacturing, while the goat milk, generally, is used as a supplement to sheep for the production of

protected designation of origin (PDO) cheeses, such as feta, or other traditional cheeses. Therefore, the quality of sheep and goat milk in terms of both nutritional properties and hygienic features can play an important role in payment schemes as well as in milk processing and the maturing profile of cheese. Milk quality is affected by several parameters including but not limited to lactation stage, animal health, feeding practices, milking practices, hygiene of farms, and milk transportation.

In the case of Greece, according to the National Statistical Service, the total dairy sheep holdings account to 83 856. Holdings are categorized in respect to their size; more specifically 14 900 holdings refer to holdings with 1 to 9 sheep, 28 720 holdings refer to holdings with 10 to 49 sheep, 12 973 holdings refer to holdings with 50 to 99 sheep and 27 262 holdings refer to holdings with 100 and more sheep. Most of these holdings (> 20 %) are in West Greece, while the rest are distributed all over the country.

NTUA project team reached in total 21 sheep farming companies and mainly associations, in which the questionnaire was distributed. The questionnaires distributed to livestock farmers, include the questions presented in Section 2.

The answers received were only ten, but still provide some valuable feedback regarding the hurdles and bottlenecks of the orange peel value chain. Moreover, the answers received provide a general guideline for the NEWFEED project team in relation to the stakeholder's requirements, in order for the incorporation of orange peel in feed products.

Base on the analysis presented in Table 1, it is concluded that a percentage equal to 66,7 % of the respondents stated that the reason why they don' t currently include any organic by-product as an ingredient in their formulations is the **small availability**, followed by the fact that nobody has **suggested any relevant ingredient**, with a gravity factor of 33,3 %.

In relation to **price**, a percentage of 10 % stated that they would like the derived product to be cheaper than the currently commercial animal feed. In relation to **consumer acceptance**, only 11,1 % in this case expressed the concern already noted, regarding Feed producers, that the new feed will not be accepted due to the fact that the raw material is derived from food waste.

The **two main concerns** that the livestock farmers expressed is on one hand whether the inclusion of a new ingredient in the formulation of animal feed will result in a product that will be promoting animal' s health and productivity, as well as the regulative and auditing frame in Greece which doesn't guarantee a safe space for initiatives uptake on behalf of the Livestock farmers.

Table *1. Analysis of questions*

Question	**Answer-Hurdle**	**Gravity factor/hurdle**
What is the reason, for which you don' t currently include any organic by-product as an ingredient in your formulation?	1. Nobody has suggested the inclusion of a new ingredient to me	33,3 %
	2. Small availability	66,7 %
In relation to Price, which are your main requirements?	3. Cheaper than the currently commercial animal feed	10 %
In relation to Consumer acceptance, what would be your concerns?	4. Small acceptance due to the fact that the raw material is derived from food waste	11,1 %

If you have selected Other requirement, what would be your concerns?	5. To promote animals' health and productivity	50 %
	6. Our main concerns come from the fact that in Greece very few suppliers provide certified products that regard to the quality, the nutritional value and the production process, as well as the attitude of avoiding taking the respective responsibility in case problems occur that could possibly affect the health and the efficiency of productive animals	50 %

On the other hand, according to Table 2, the respondents (44,4 %) that stated they don't currently include any organic by-product as an ingredient in the formulation, are **interested** in doing so. Regarding the criteria for doing so, **price** is predominant (100 %), followed by the **nutritional value** (90 %), the **Supply Guarantees** (60 %), the **Food Safety** (50 %) and the **Origin** (20 %).

In relation to **Price**, 50 % stated that they would like the price to remain the same with the currently used animal feed, while a percentage of 40 % stated that price is not a crucial parameter, if the quality of the ingredient is high.

In relation to **Nutritional value**, the requirement that the new feed is a source of protein is again a top priority also for the livestock farmers, with a gravity factor of 80 %, followed by the digestibility and the simultaneous fulfilment of multiple parameters such as protein content, fibre content, lipid content digestibility and immunostimulant properties.

In relation to **Supply Guarantees**, half of the correspondents expressed their preference towards special agreements (<1 year), followed by a 30 % that prefers short-term commercial supply agreement (< 2 years) and a 20 % that prefers Mid-term commercial supply agreement (2-5 years).

In relation to **Sustainability**, in this case and in contradiction with the Feed producers, the Livestock farmers are split in two; one half would be interested in a new raw material with a smaller environmental footprint and one half would be interested in the possibility of a market expansion.

Table *2. Analysis of questions*

Question	**Answer**	**Gravity factor/hurdle**
Do you currently include any organic by-product as an ingredient in the formulation?	1. Yes	55,6 %
	2. No	44,4 %
If you don' t currently include any organic by-product as an ingredient in your formulation, would you be interested to do so?	3. Yes	100,0 %
	4. Price	100,0 %

What are the most important requirements when integrating a new ingredient in your formulations?	5. Nutritional value	90,0 %
	6. Supply Guaranties	60,0 %
	7. Food Safe	50,0 %
	8. Origin	20,0 %
	9. Consumer acceptance	0,0 %
In relation to Price, which are your main requirements?	10. Same price with the currently used animal feed	50,0 %
	11. Price doesn't play role, if the quality of the ingredient is high	40,0 %
In relation to Nutritional Value, what are your requirements?	12. Source protein	80,0 %
	13. Easily digestible	10,0 %
	14. Protein source, fibre source, lipids source, easily digestible, immunostimulant	10,0 %
In relation to Supply Guaranties, what would you be interested in?	15. Special Agreements (< 1 year)	50,0 %
	16. Short-term commercial supply agreement (< 2 years)	30,0 %
	17. Mid-term commercial supply agreement (2-5 years)	20,0 %
In relation to Sustainability, what would you be interested in?	18. New raw material with a smaller environmental footprint	40,0 %
	19. Possibility of market expansion	40,0 %
In relation to Origin, what are your requirements?	20. Full control of the food safety parameters (beyond what legislation requires)	50,0 %
	21. Compliance with the legislation	50,0 %

4.3 Success stories

The valorization of orange peel by-products for use as animal feed has gained attention due to its potential benefits, including reducing food waste and providing a sustainable source of nutrition for animals. While this field is still evolving, some success stories and promising initiatives have emerged.

Florida Citrus Pulp and Molasses: In Florida, where citrus fruit production is significant, the by-products of orange processing, have been used successfully as animal feed. These by-products are rich in fiber and energy, making them suitable for livestock feed, particularly for cattle and dairy cows.

The Florida Citrus Pulp and Molasses system is a well-established process for valorizing by-products of the citrus industry, particularly the orange processing industry. These by-products, primarily citrus pulp and molasses, are generated during the extraction of juice from oranges and other citrus fruits. The system aims to convert these by-products into valuable resources, including animal feed and other agricultural products.

The system begins with the generation of citrus pulp and molasses as by-products during the citrus fruit processing operations, which mainly involve juice extraction. Citrus pulp is the fibrous residue left after juice extraction, while molasses is a syrupy, high-sugar by-product. Then, the citrus pulp and molasses are collected and stored in suitable containers or silos. Proper storage is essential to prevent spoilage and maintain the quality of these by-products. The collected citrus pulp and molasses may undergo processing to enhance their nutritional content and durability. Processing methods can include drying (e.g.), pelleting, and/or blending with other ingredients to create a balanced animal feed product. These processes make the feed more convenient for handling and feeding animals. Citrus pulp is rich in dietary fiber and provides a source of energy for livestock, while molasses is high in sugar content. When combined, they can provide a balanced nutritional profile for animals. The processed citrus pulp and molasses are used as animal feed, primarily for cattle and dairy cows. The feed can be delivered in various forms, such as pellets or meal, and it serves as a source of energy, fiber, and additional nutrients in the animals' diets. One of the key advantages of the Florida Citrus Pulp and Molasses system is that it provides a cost-effective feed option for livestock farmers. The use of by-products reduces the need for expensive feed ingredients and can lead to cost savings in animal production. Utilizing citrus pulp and molasses as animal feed helps reduce food waste and promotes sustainability. Rather than discarding these by-products as waste, they are transformed into valuable resources, contributing to a more environmentally friendly citrus processing industry. Collaboration between citrus processing plants and livestock farms is often crucial in establishing a supply chain for citrus pulp and molasses as animal feed. Such partnerships ensure a reliable source of feed for the agriculture sector while reducing waste and improving the economic viability of both industries. The Florida Citrus Pulp and Molasses system exemplifies the concept of circular economy, where waste products from one industry are repurposed into valuable inputs for another. This not only reduces waste but also supports the sustainability and profitability of both the citrus processing and livestock farming sectors.

Citrus Waste to Livestock Feed in Brazil: Citrus waste to livestock feed initiatives in Brazil are a significant part of the citrus industry's efforts to minimize waste and create value from by-products. Brazil is one of the world's largest citrus producers, and as a result, there is a substantial quantity of citrus waste generated during the processing of oranges and other citrus fruits. The conversion of this waste into livestock feed is an environmentally friendly and economically viable approach.

Citrus waste is generated during the processing of citrus fruits, primarily during juice extraction. This waste includes peels, pulp, seeds, and other residues that are not used for juice production. These by-products can be a significant environmental concern if not properly managed. It is collected from processing facilities and stored in silos or bins. Proper storage is essential to prevent spoilage and maintain the quality of the waste. One common method applied for processing citrus waste is dehydration. Dehydration reduces the moisture content, prolongs the shelf life, and makes the material easier to handle and transport. Dehydrated citrus waste can be in the form of pellets, powder, or flakes. Depending on the target livestock and their nutritional requirements, the dehydrated citrus waste may undergo further processing to enhance its nutritional value. This can include blending it with other feed ingredients to create a balanced animal feed product. Quality control measures are implemented throughout the processing to ensure the feed product is safe and meets nutritional standards. This may involve testing for moisture levels, nutrient content, and any potential contaminants. The processed citrus waste, now converted into livestock feed, is distributed to livestock farms and ranches. It is typically packaged in bags, bulk containers, or bulk shipments, depending on the scale of production and distribution. By converting citrus waste into livestock feed, these initiatives reduce the environmental impact of waste disposal. Citrus waste is diverted from landfills, reducing the carbon footprint and contributing to more sustainable agricultural practices. Collaboration between citrus processing plants and livestock farms is often a crucial aspect of these initiatives. Establishing a reliable supply chain ensures a steady source of feed for livestock, while citrus processors benefit from waste reduction and added revenue.

The Citrus Waste to Livestock Feed system in Brazil is also an excellent example of a circular economy approach, where waste materials from one industry are converted into valuable resources for another. It helps address waste management issues, promotes sustainability, and provides cost-effective feed options for livestock farmers. This system is a win-win for both the citrus processing industry and the livestock agriculture sector in Brazil.

Citrus Peel Pellets for Swine: In some regions, citrus peel pellets have been used as a component of swine diets. The high fiber content can be beneficial for the digestive health of pigs, and the pellets are cost-effective. This approach has been successfully integrated into the feeding regimens of many pig farms.

The process begins with the collection of citrus peels, which are generated during the juice extraction process at citrus processing plants. These peels typically consist of the outer skin and residual pulp of citrus fruits, such as oranges. The collected citrus peels are initially washed to remove any contaminants and residue. The cleaning process ensures that the peels are free from dirt and unwanted substances. To reduce the moisture content and extend the shelf life of the citrus peels, they are typically subjected to drying. Drying can be achieved using various methods such as air drying, sun drying, drum drying, or even specialized drying facilities. The goal is to reduce the moisture content to a suitable level for pelletization. After drying, the citrus peels are often ground into a fine or coarse powder. Grinding helps break down the fiber structure, making it easier to form pellets. The size of the grind can be adjusted to suit the specific requirements of the pelletizing equipment. The ground citrus peels are then passed through a pelletizing machine. This equipment compresses the material into pellets by using pressure and heat. Binders may be added to help the pellets maintain their shape and integrity. Quality control measures are in place to monitor the production process. This includes checking the moisture content, pellet density, and pellet size to ensure that the final product meets the desired specifications. The citrus peel pellets are typically packaged in bags, totes, or bulk containers. Proper packaging helps preserve the quality of the feed during storage and transportation. Depending on the specific nutritional requirements of swine, the citrus peel pellets may be blended with other feed ingredients. This can include protein sources, grains, vitamins, and minerals to create a balanced swine feed. The finished citrus peel pellets are distributed to swine farms and integrated into the animals' diets. Swine can benefit from the fiber content in citrus peels, which can support their digestive health. The production and distribution of citrus peel pellets for swine feed are subject to regulatory standards and quality assurance protocols to ensure the safety and nutritional value of the feed product. The production of citrus peel pellets for swine is a sustainable practice that helps reduce waste from the citrus processing industry while providing a cost-effective and nutritious feed source for swine. This circular approach contributes to the utilization of by-products, reduces environmental impact, and supports swine farming operations.

The case studies/success stories presented above mainly involve drying as a treatment step. Thus, there is no alteration or upgrade in the composition of the raw material, apart from the removal of moisture. Nevertheless, the production of silage from orange peels is another successful practice that has been applied where few physico-chemical processes occur.

Silage is produced in order to feed animals in periods when feed supply is inadequate, either in terms of quantity or quality. Orange silage is a marketable product that is produced from orange juice waste and is used as forage. Global changes in climate (e.g. lower levels of rainfall particularly in arid and semi-arid areas) underline the need for forages adapted to drier conditions compared with conventional forage (e.g. corn, a major source of forage for dairy farms).

Orange silage is produced from orange pulp, namely the dried residue of peel, pulp and seeds of oranges. Amongst its advantages are the following:

- It can be used either fresh or mixed.

- It utilizes fresh orange pulp which is a raw material not easily manageable towards an animal feed which can be used for all ruminants as a substitute to cereals and alfalfa.

- It can substitute up to 75 % of corn silage without any negative impact on the animal' s growth and the meet quality, though the percentage for the optimum animal fattening is 50 %;

- It is greatly palatable to ruminants.

- It promotes digestibility and reduces consumption without having a negative impact on the sheep growth, the wool production nor the animal' s weight.

Description of Silage Technique

Silage is basically a fermentation process. The fermentation process involves both aerobic (oxygen needing) and anaerobic (non-oxygen needing) bacteria and is generally divided into 6 different phases. Aerobic fermentation occurs when the silo or bag is being filled (phase 1) and at feed out (phase 6). The rest of the phases (phases 2 through 5) occur under anaerobic conditions.

The six different phases are presented as follows:

Phase 1: Phase 1 starts at harvest and under ideal conditions of moisture, chop length, and firm packing lasts only a few hours. This initial phase continues until either the oxygen supply or water-soluble carbohydrates have been depleted. The most notable feature of this phase is the increased temperature of the newly fermenting crop resulting from ongoing cell respiration where carbon dioxide, water and heat are produced. In poorly sealed and/or packed silos, bunk life of the resulting feed can be reduced since the initial growth of aerobic spoilage organisms (yeasts and Bacillus species) occur during this phase. Once feedout occurs, yeasts can rapidly increase in numbers causing heating in the feedbunk and lowered feed consumption.

Phase 2: Phase 2 begins when the trapped oxygen supply is depleted and generally lasts no longer than 24 to 72 hours. During this phase, anaerobic (without oxygen) hetero fermentation occurs. The primary bacteria during this phase are Enterobacteria. They can tolerate the heat produced during the aerobic phase and are viable in a pH range of 5 to 7 which is found in the fermenting forage at this time. These heterofermenters produce both acetic and lactic acid but tend to be inefficient at producing these acids relative to nutrients lost in the fermenting crop. The final proportions of these acids depend on the crop maturity, moisture, and natural bacterial populations. When the pH drops below 5, homo-fermenters predominate and phase 3 of silage fermentation begins.

Phase 3: Phase 3 is a transitional phase that generally lasts only 24 hrs. During this phase, the homo-fermentative bacteria, which are more efficient than the heterofermenters, rapidly drop the pH of the fermenting forage by efficiently producing lactic acid as an end-product. As the temperature of the silage mass decreases and the pH continues to drop, the bacteria in this phase become inhibited and phase 4 lactic acid bacteria increase.

Phase 4: This phase is a continuation of phase 3 with a stabilization of temperature of the fermented crop. Homo-fermentative bacteria convert water-soluble carbohydrates to lactic acid, which is very effective at dropping the pH which helps preserve silage. In well-fermented silages, lactic acid can account for over 65 % of the total volatile fatty acids. The final pH of an ensiled crop depends on the type of forage and moisture content of the ensiled forage. Legumes, i.e. alfalfa, have less water-soluble carbohydrates, a higher buffering capacity, and generally reach a final pH of about 4.5. Corn silage, in contrast to grasses and legumes, has a lower buffering capacity, more water-soluble carbohydrates, and generally reaches a pH around 4.0. When the terminal pH is reached, the forage is preserved within the silo. Silage pH does not indicate the rate or quality of the resulting fermentation. To determine the quality of the fermentation, a fermentation analysis

is needed where the amount of acetic, lactic and other acids are determined. Phases 2, 3, and 4 generally are completed within 10 days to 3 weeks from harvest. Thus, the general recommendation is to wait at least 3 weeks before feeding newly harvested forages. The length of this fermentation process will vary depending on the crop harvested (related to buffering capacity), moisture, and maturity of the ensiled crop. Properly applied, high-quality inoculants may decrease fermentation time required.

Phase 5: This phase lasts through the remainder of storage where the fermentation process is stable as long as oxygen does not penetrate silage, i.e., through silo walls with final temperature of well-preserved silage being 24 to 30 °C. However, changes do occur in the digestibility of the nutrients found in these forages. First, studies show that with longer storage times, starches become more quickly degraded in the rumen. Secondly, changes also may occur in the digestibility of the neutral detergent fibre (NDF). Some studies have shown an increase in the digestibility of NDF with longer storage times whereas another study has shown no changes with storage. In one study where NDF digestibility was significantly increased, NDF digestibility appeared to plateau 6 months from ensiling.

Phase 6: This phase occurs during feed out, is just as important and often neglected part of the fermentation process and can result in substantial dry matter losses as oxygen is reintroduced into the fermented crop. Proper management of the silage face and at the feedbunk can minimize dry matter losses and optimize feed intakes by dairy cows.

In Greece, there are 2 companies that produce orange pulp silage and market it as animal feed. MGK Koinonos is located in Attica Greece (https://mgkk-ike.gr/). The company was established in September 2019 and deals with the management of any organic by-product from Greek juice factories, food and beverage industries as well as from livestock and poultry farms. The main raw materials for MGK products (organic fertilisers and animal feed) are oranges, apples, pomegranates, pears, marc, stone kernels, organic food-only food purifiers, brewer's yeast, brewer's spent grains and manure from goats, goats, chickens. Orange silage is produced from orange pulp from juice factories. These materials, immediately after the juicing of orange fruits, are transferred to MGK facilities, where they are treated in order to remove the initial moisture. The product is immediately silage (maximum 5 hours after juicing) in large bags. Its availability for consumption can be immediate, as fresh, because the pH of the product is not alkaline but acidic. Orange silage can be kept in excellent conditions in the bag for a period of one year. Orange silage is packed in bags of 30 kg or is sold in bulk (~750 kg). The characteristics of MGK produced orange silage are:

- Moisture: 65 %
- Energy: 16 MJ / Kg
- Ash: 12 %
- Total Nitrogen: 1,5 %
- Proteins: 10 %.
- Fats and Oils: 1,5 %
- pH: 4,5 – 5
- Free sugars: 12 %

The price of this product 80 € per ton.

The other Greek company is ENZO (http://enzo.com.gr/el/) and is located in Lakonia, Greece, where the majority of orange juice industries are located too. The final product is packed either in bags of 30 kg or is

sold in bulk (Big bags 1 tn) and should be stored in a clean and shady environment. The characteristics of ENZO orange silage is presented in Table 3.

Table *3. Characteristics of ENZO orange silage*

Parameter	**Unit**	**Value**
Moisture	%	68-74
Dry matter	g/100 g	26-32
Crude protein	% DM	8-10
Crude fibre	% DM	15
NDF	% DM	21
ADF	% DM	16
Gross Energy	MJ / kg DM	16,0
Organic Digestibility for ruminants	%	87
Digestibility of energy content in ruminants	%	83
Digestible Energy (DE)	MJ / kg DM	15
Metabolic Energy (ME)	MJ / kg DM	12,5
Calcium (Ca)	g/kg DM	13
Phosphorous (P)	g/ kg DM	1,0
Fats and Oils:	g /100 g	0,4
Saturated	% Fats	81,91
Monosaturated	% Fats	9,8
Polysaturated	% Fats	829
Total ω3	% Fats	2,96
Total ω6	% Fats	532
Contains sugars, vitamin A, vitamin E and numerous antioxidants Free of B1, B2, E1, E2		

According to ENZO, the silage of orange pulp, is an **excellent feed for ruminants.** The fresh product, with a multitude of antioxidants and vitamins, contains all those beneficial ingredients that promote animal health. This product is a completely natural food, very tasty, with a pleasant aroma and excellent levels of digestible fibres, as a result of which it is accepted by animals. There is availability of the product all over the year. Due to its high energy density and especially the high digestibility of the organic substance of the pulp (approximately 87 %), it is concluded that the silage of orange pulp has the quality characteristics of concentrated feed. Thus, its addition to the diet results in an increase in both milk and milk fat content, as

well as in muscle tissue for fattening animals. Orange silage is suitable both for dairy animals (sheep, goats & cows) and for growing animals (lambs & calves). ENZO proposes for ruminants' addition in the daily diet, up to 1,5 % of their body weight gradually over a period of one week.

Apart from orange silage, Lakonia juices industry produces two marketable animal feed products namely Dried orange pulp in pellets and Dried orange pulp in flakes. Dried orange pulp in the form of **pellets** is an excellent feed enriched with orange molasses (about 20 %) and rich in pectin and digestible fibrous substances, which ensures the smooth functioning of the animals' digestion, while reducing the cost of feeding. This **pellet** feed is available in the following packages: bags of 50 kg, big bags of 800 kg and in bulk on tipper or sliding truck. Dried orange pulp in the form of **flakes** is also an excellent animal feed enriched with orange molasses (about 20 %) and rich in pectin's and digestible fibrous substances, which ensures the smooth functioning of the animals' digestion, while reducing the cost of feeding. **The flakes** feed is available in the following packages: 25 kg bags and big bags of about 550 kg.

Apart from the case studies/success stories presented above, various research projects have also been exploring the potential of orange peel by-products in animal feed. Scientists are working on optimizing the nutritional value, digestibility, and taste of these by-products for different animals. Some experimental studies have shown that the inclusion of citrus pulp in poultry diets can lead to improved egg production and eggshell quality.

One of the significant advantages of using orange peel by-products as animal feed is its potential to reduce environmental impact. By diverting organic waste from landfills and using it as a valuable resource in animal agriculture, these initiatives contribute to sustainable agriculture practices.

In some cases, collaborations between citrus processors and local agribusinesses have been successful in establishing a supply chain for orange peel by-products as animal feed. Such partnerships can ensure a steady source of feed and create a win-win situation for both industries.

It's important to note that while there have been successful initiatives, there are also challenges, such as ensuring the quality and safety of the feed and addressing potential anti-nutritional factors in citrus waste. However, the valorization of orange peel by-products as animal feed represents a promising opportunity to reduce food waste, support sustainable agriculture, and create economic value from what was once considered waste.

5. Case study 3 - Olive cake value chain

5.1 Chemical composition

The average composition of olive cake coming from olive oil industries is presented in the table below (Table 17).

Table 17. Composition of olive cake by-product coming from olive oil production industries (% d.b.)

Parameters	Olive Cake
Ash (%)	3.43
CP (%)	6.53
CF (%)	45.25
EE (%)	14.77
NFE (%)	35.19
NDF (%)	91.77
ADF (%)	74.26
ADL (%)	41.74
Hemicellulose (%)	17.83
Cellulose (%)	32.19
Lignin (%)	39.78
GE (cal/kg)	4,613

As far as **antinutritional parameters and undesirable substances** like pesticides, molds, bacteria are concerned, it should be taken into account that given the industrial safety procedures and actions taken, along with the high temperature drying step in the downstream processing, the possibility of contaminants presence is very low. However, specific analyses for possible contaminants, pesticides and microorganisms will be carried out in the following production batches in WP3

5.2 Hurdles and Bottlenecks identified

This value chain consists of the use of by-products from the olive oil industry to produce an improved ingredient for poultry (broilers).

The survey highlighted some points are:

1) The participants don't rely on technologies

2) Most of them are limited to their surroundings. Therefore, they don't have access to a diverse market

3) They lack space, available and reliable transportation.

4) The participants mainly link between the price of the product and their customer needs.

5) They are open to different and more sustainable solutions to provide more revenue.

The survey highlighted some concerns are:

1) Products can be pricy for their customers.

2) Products won't provide the needed nutritious value.

3) Competition with a famous brand will have a negative impact on the new product and its distribution.

4) Not following Food Safety Law.

The main aspects by sector are shown below:

5.2.1 Food industry

- Types of Organic waste: Olive Cake
- 100-1000 tons a year, every 6 months
- recycle in medical and cosmetics filed
- There is income for collecting the waste. While managing the waste storing is the main issue.
- Due to lack of space. There are no private trucks to transport the waste on a regular basis

5.2.2 Logistic & processing

- The main problem the life cycle of the agriculture residues

5.2.3 Feed industry

- Reducing the cost - increasing the profit - the possibility of establishing a small factory
- Food factory waste increased

5.2.4 Livestock

- Environmental concerns
- Food safety problems
- Need less prices
- Guarantee of supply and restricted polices

5.3 Success stories

Due to growing rivalry between humans and animals for the same feed resources, feeding costs and the price of poultry products have lately grown globally. Valuable feed ingredients that can be utilised for animal nutrition are agriculture by-products. Feed processing and feed additives have also been employed in animal nutrition to increase the feeding values of feeds, especially those made mostly of agricultural byproducts. Because pelleting has a number of advantageous benefits, it is employed in feed manufacturing to improve the use of agricultural byproducts. One potential solution to the lack of animal feed supplies is to recycle olive cake (OC) for use as a feed resource in livestock feeding. Between 5 and 10% of mash feed containing olive cake did not negatively affect layers' or broilers' meat or egg production (Abo Omar 2000, 2005; El hachemi et al. 2007; Al-Harthi and Attia 2015, 2016); the same was true for broiler pellet feed, where up to 15% of the cake was added (Al-Harthi et al. 2019).

Regarding the innovation of this case study, this proposal showed different strategies from other studies that use olive cake pomace for animal feeding. The innovation of this proposal is mainly based on:

1) the olive oil itself that it is obtaining by different processing of olives;
2) the solid-state fermentation process using olive cake native microbial community;
3) the targeted species of poultry (chicks).

In addition, this study showed different strategies which are completely different from other studies as they used olive extract with different feed additives (monensine) which had been done in the University of (Madrid 2020) and also by different poultry species.

Regarding the microbial community in this research The Olive Cake (OC) native microbiextract community was utilised to create the Microbial Isolate. With this purpose, ten grammes of dried OC were combined with ninety millilitres of sterile distilled water to produce a 10-1 dilution. Next, 0.1 millilitre of the suspension was added to nine millilitres of distilled water to produce a dilution, and this process was continued until a 10-5 dilution. On the surface of potato dextrose agar (PDA) medium (Difco Laboratories, Detroit, USA) for fungus and yeast, and solidified nutritional agar (cross et al.,1998) plate for bacteria, 0.1 ml from each dilution was applied. The PDA plates were incubated at 25°C, whereas the nutritional agar plates were incubated at 30°C. After incubation, separate colonies different in shape, color and margins were picked up and re-streaked on surface of the suitable media to obtain pure isolates then were stored as on Nutrient agar slants for bacteria and on PDA slants for the fungi (Ismaili-Alaom et al., 2003).

Also, other studies had shown a feeding trial was run to assess the effect of olive cake (OC) in pelleted diets at 0, 10 and 15% with or without 500 FTU/kg diet of a bacterial E. coli phytase (BECP) for broiler chickens during early growth phase period (7–28 days of age).
In this case study the chosen fungal isolate was cultivated on PDA broth medium, incubated for three to five days at 28°C, centrifuged for five minutes at 12,000 g, and then rinsed three times with 0.85% NaCl solution. The CTAB method, as outlined by Zhang et al. (2010), was utilised to extract the genomic DNA. The DNA aliquots were stored for later analysis at 20°C.
In a word, it is possible to maximize the nutritious qualities of agro-industrial by-products by using the fermentation process, based on the study's findings. Utilising its natural microbiota, OC was bioconverted to improve its digestibility and nutritional value for use in grill diets. Consequently, there would be a large drop in the cost of feeding, an improvement in financial returns, and a reduction in environmental pollutants. The use of modified OC in chicken feeding has better economic and environmental conditions, and the effect of SSF should be seen as a contributing factor to these improvements.

Abo Omar J. 2000. Effect of different levels of olive pulp on the digestibility of broiler chicks. Bethlehem Univ J. 12: 34–40.
Abo Omar J. 2005. Carcass composition and visceral organ mass of broiler chicks fed different levels of olive pulp. J Islamic University of Gaza (Series of Natural Studies and Engineering). 13:75–84.

6. Annex

Questionnaire answers for case study 1

newfeed

FEED FROM FOOD INDUSTRY BY-PRODUCTS

Section 1 of 6

NEWFEED

Proyecto NEWFEED (www.newfeed-prima.eu)

El objetivo general del proyecto NEWFEED es desarrollar ingredientes alternativos para alimentación animal mediante un enfoque de economía circular a través de la conversión de subproductos alimentarios en piensos secundarios de alto valor para la alimentación animal.

Se validarán tres cadenas de valor en el área mediterránea y se crearán nuevas oportunidades de negocio teniendo en cuenta un enfoque multi-actor en su concepción, configuración y su evaluación de sostenibilidad.

El propósito de este cuestionario es identificar los obstáculos y cuellos de botella de 3 cadenas de valor (desde las materias primas hasta los consumidores) que pueden afectar al uso de estas materias primas alternativas como piensos secundarios para la alimentación anima. Estas tres cadenas de valor son:

1) Utilización del raspón de la uva de las bodegas para el ganado ovino y bovino lechero. Este estudio de caso está dirigido por el centro de investigación alimentaria AZTI (www.azti.es) y será validado en España.

2) Utilización de la piel de naranja de las industrias de zumo de naranja para las ovejas lecheras. Este estudio de caso está dirigido por National Technical University of Athens (NTUA) y se validará en Grecia.

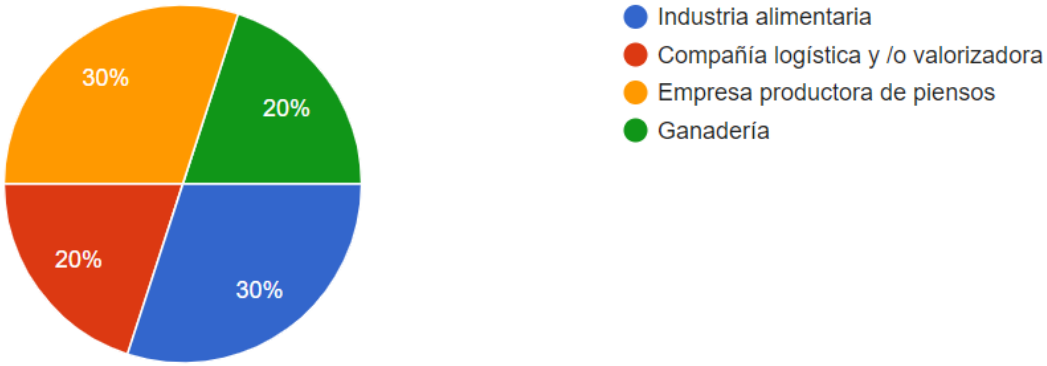
3) Utilización de la subproductos de la industria del aceite de oliva para las aves de corral. Este estudio de caso está dirigido por la Heliopolis University for Sustainable Development (HUSD) y se ha validará en Egipto.

El análisis de los datos obtenidos permitirá detectar los obstáculos y cuellos de botella que afecten a la implementación de las soluciones de valorización, así como la identificación de casos de éxito, para garantizar el éxito de la valorización de estos subproductos como ingredientes alternativos para alimento animal.

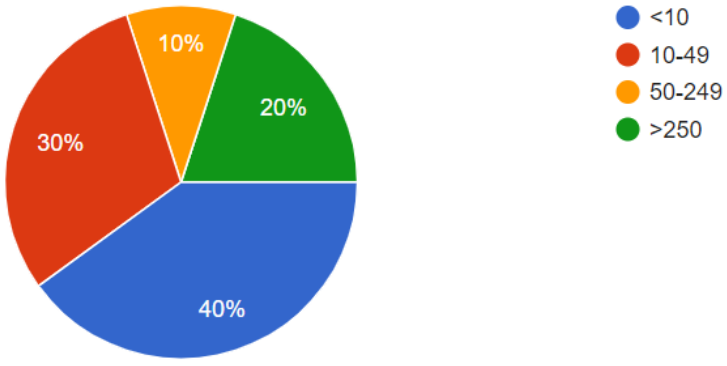
El proyecto NEWFEED ha recibido financiación del programa PRIMA de la Unión Europea para la Investigación, Desarrollo tecnológico y Demostración bajo el acuerdo marco nº 2013.

Number of answers: 10

Percentage of answers in each sector

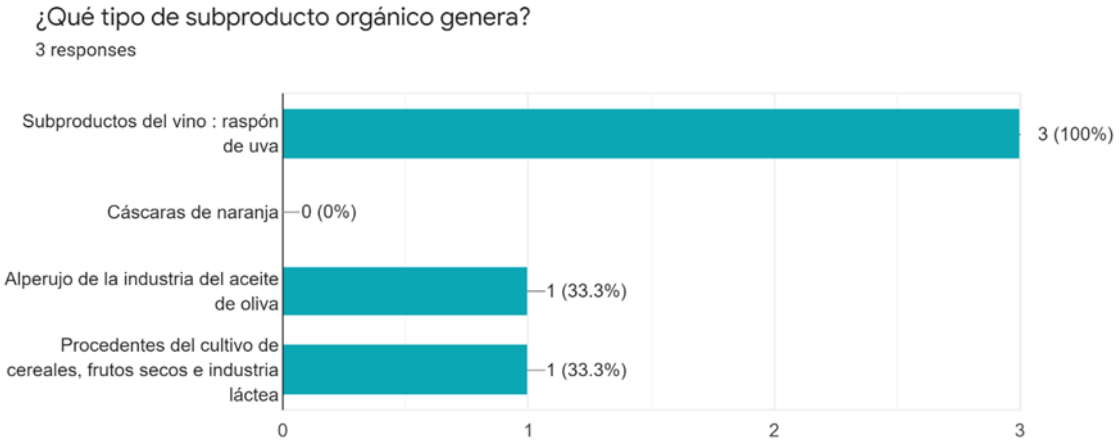


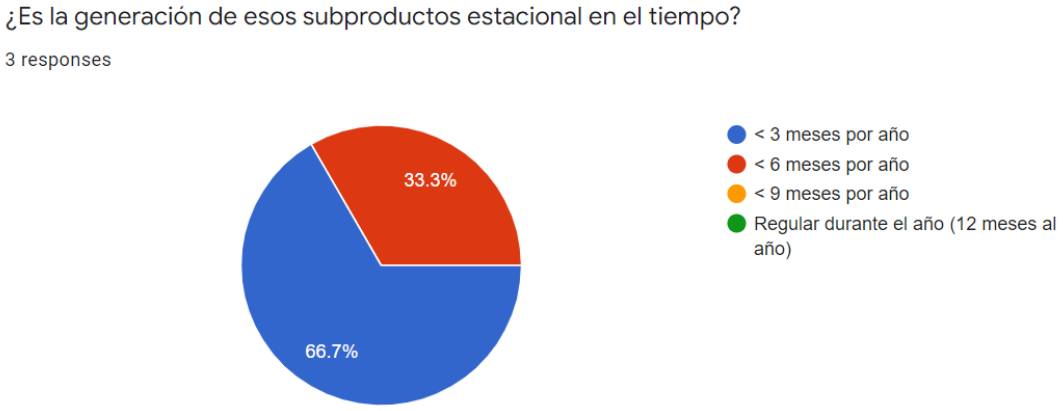
Number of employees



Food industry

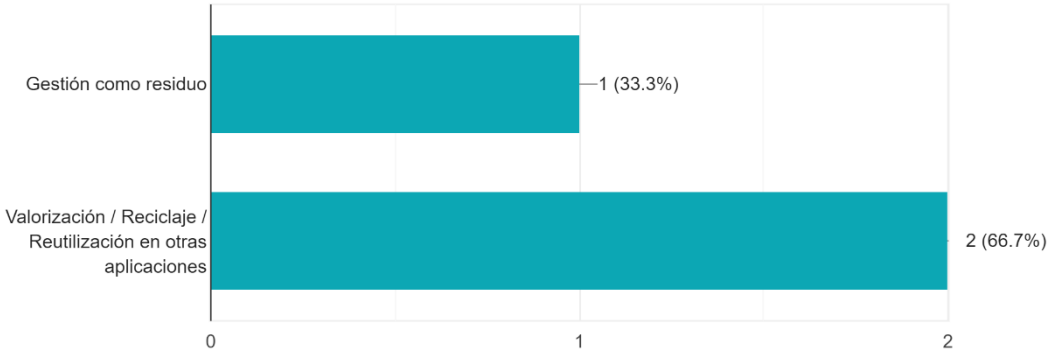
Number of answers: 3





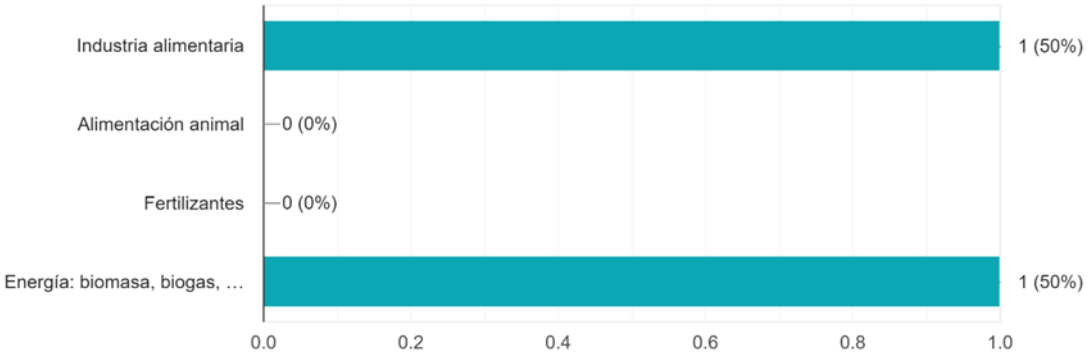
¿Cuál es la gestión actual de los subproductos orgánicos?

3 responses



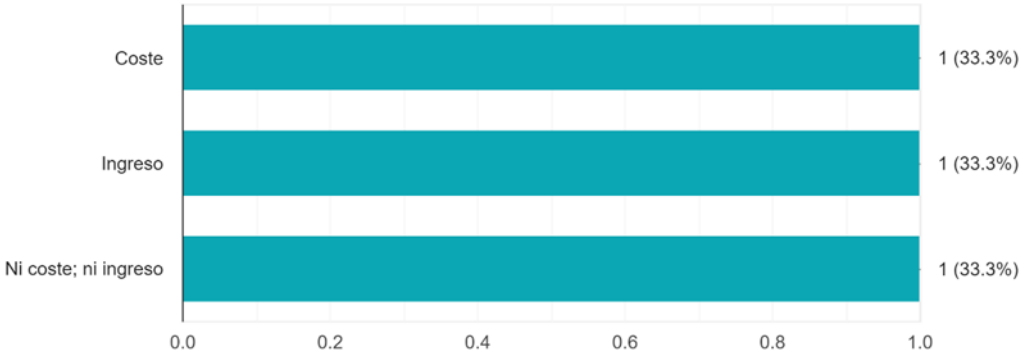
Si es valorizado / reciclado / reutilizado, ¿Para qué aplicación final?

2 responses



¿Paga por el servicio o recibe algún ingreso por la materia prima?

3 responses



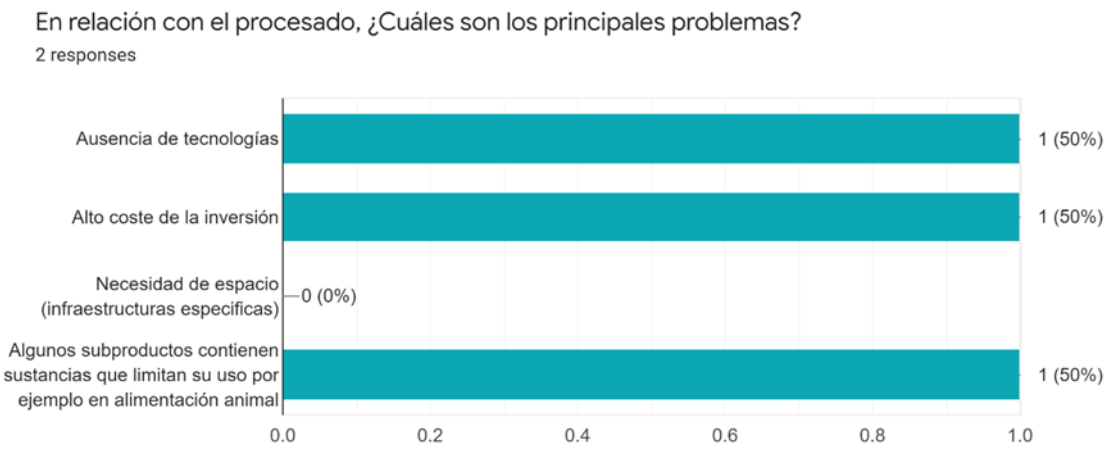
Which are the main problems that you face in the management of the by-product?

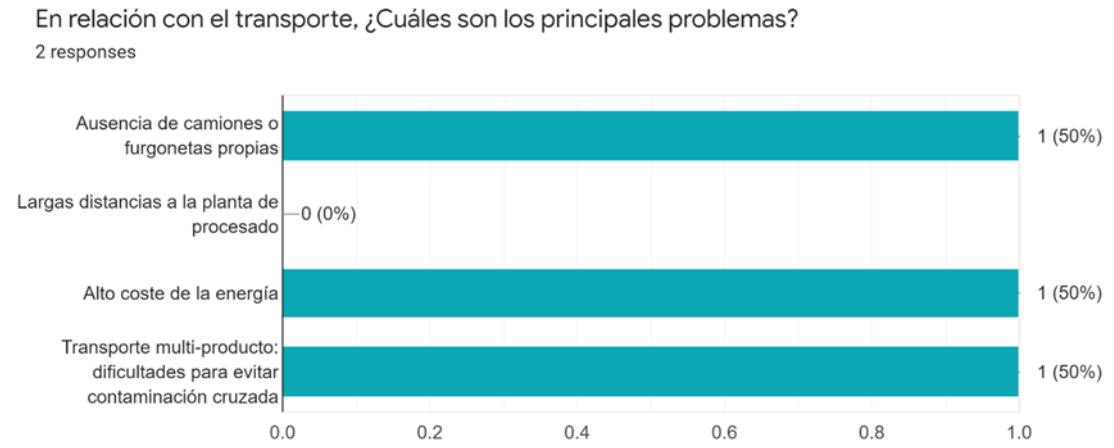
- The main problems are (from the smallest to the largest)

- commercialization of new products
- By-product processing and separation in the production lines,
- by-product storage and transport

Do you identify any other problems in managing organic by-products? Please specify

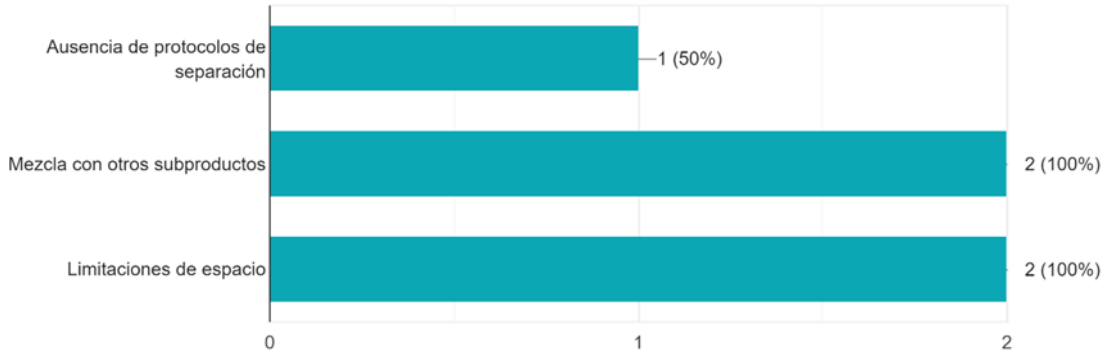
Handling of by-product/lack of specific protocols/training of by-product handlers (farmers/livestock farmers)





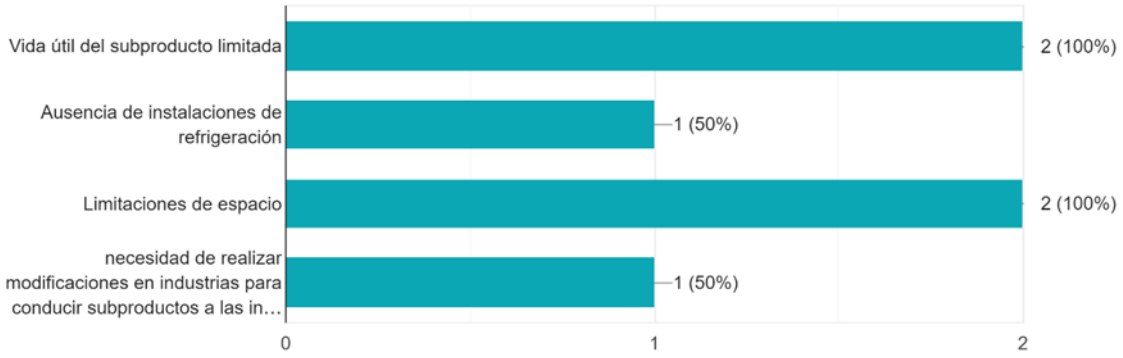
En relación con la separación de los subproductos orgánicos en las líneas de producción, ¿Cuáles son los principales problemas?

2 responses



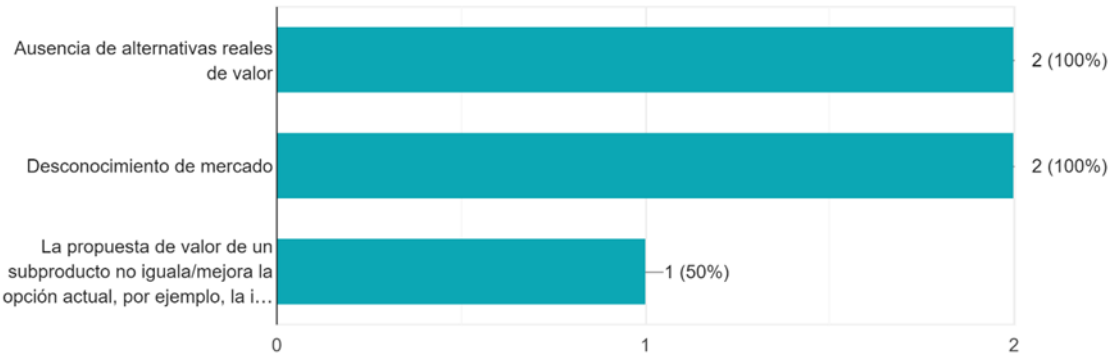
En relación con el almacenamiento, ¿Cuáles son los principales problemas?

2 responses



En relación con la comercialización, ¿Cuáles son los principales problemas?

2 responses



They will be interested in obtaining a technological solution for their by-product valorisation as ingredient for animal feed. The main reasons are:

- to add value to the by-products generated in the winery
- 1. Promote the culture of circular economy and bioeconomy in the Cooperative. 2. Assume responsibility for the sustainable use of the waste generated. 3. Diversification of products. 4. Economic benefit

They are interested in obtaining specific solutions for their companies. The main reasons are:

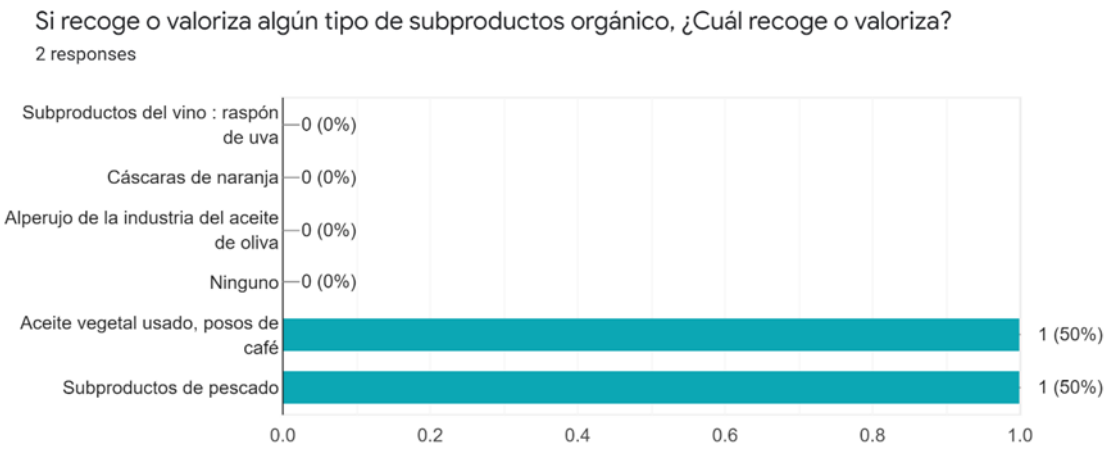
- eliminate the internal management of the by-product
- 1. Collaboration with other entities 2. participate in collaborative networks 3. evaluate the incorporation of a specific solution adapted to DCOOP's needs.

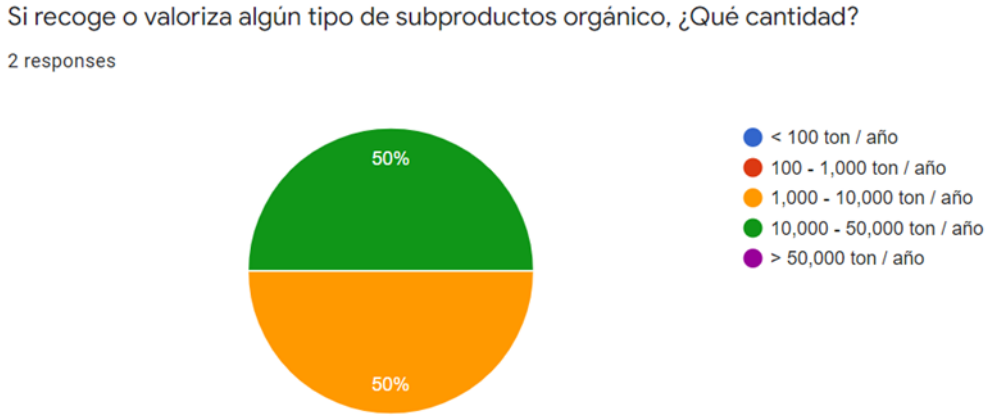
Additional information

THE GRAPE BY-PRODUCT IS DELIVERED DIRECTLY TO THE ALCOHOL PLANT FOR PROCESSING. WE DO NOT KNOW WHAT POSSIBILITIES IT COULD HAVE FOR ANIMAL FEED, TAKING INTO ACCOUNT THAT IT CONTAINS ETHANOL.

Logistic and processing

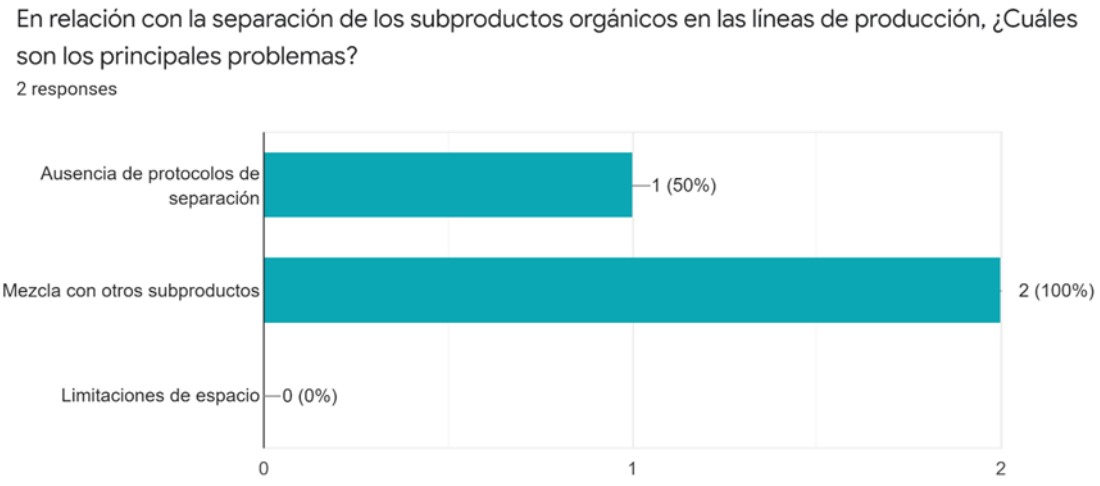
Number of answers: 2





What are the main aspects to consider when collecting or recovering waste or by-products as raw materials?

- The main problems are (from the smallest to the largest)
    - By-product processing and transport
    - by-product storage
    - commercialization of new products and separation in the production lines

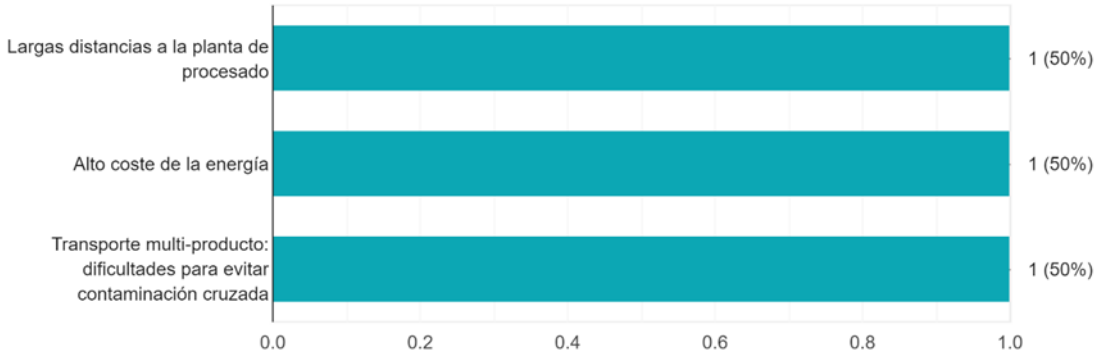


En relación con el almacenamiento, ¿Cuáles son los principales problemas?

2 responses

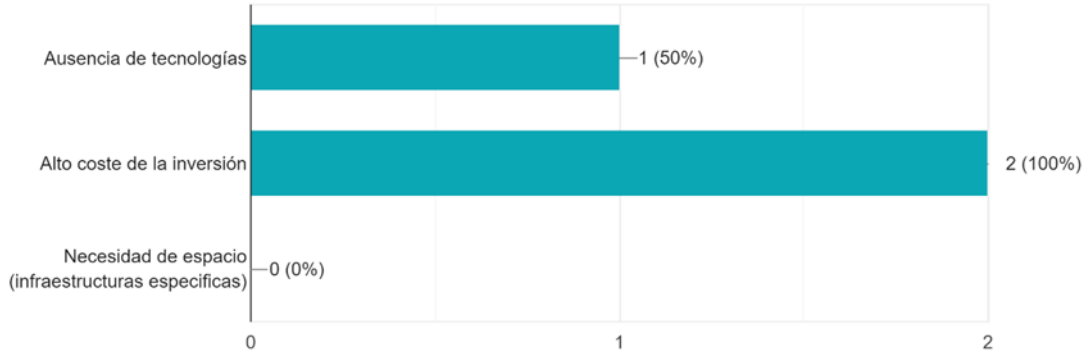
En relación con el transporte, ¿Cuáles son los principales problemas?

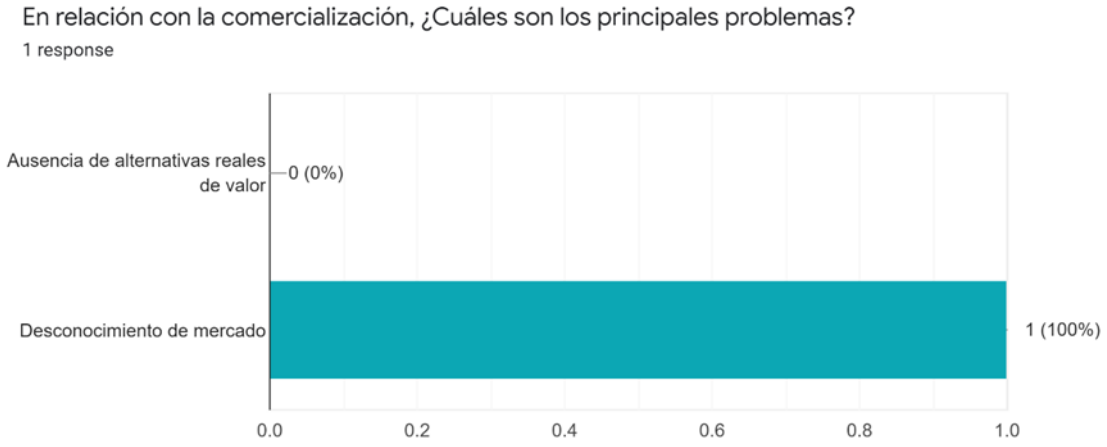
2 responses



En relación con el procesado, ¿Cuáles son los principales problemas?

2 responses





They will be interested in obtaining a technological solution for their by-product valorisation as ingredient for animal feed. The main reasons are:

- Expand markets for by-products that are already exploited today, and open markets for by-products with potential that are not used today.
- Assessing other innovative technologies against the current one.

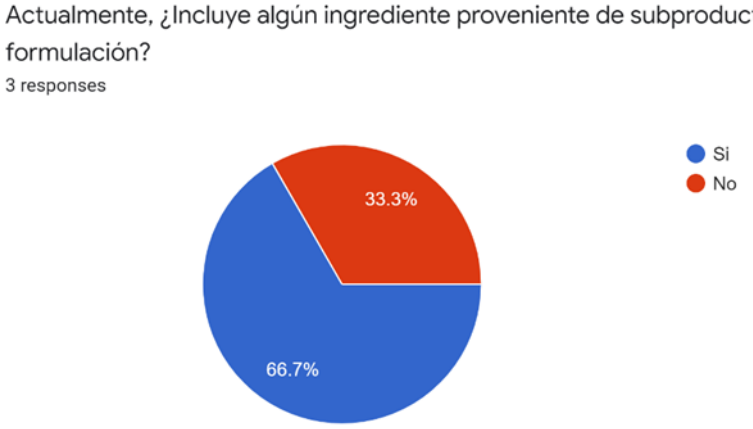
They are interested in obtaining specific solutions for their companies. The main reasons are:

- Expand markets and commercial outlets for by-products that we currently handle.
- Evaluate other technological/commercial alternatives for our by-products.

Additional information

Feed industry

Number of answers: 3



If yes, what by-product is it and why?

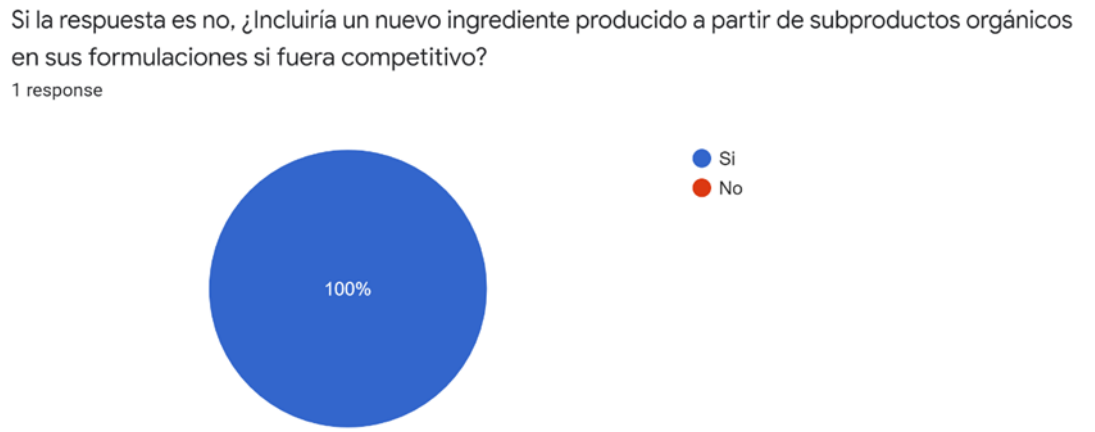
- Bran, beet and orange pulp, molasses... to make the formulation cheaper. We will study any other by-product of potential interest in animal feed.

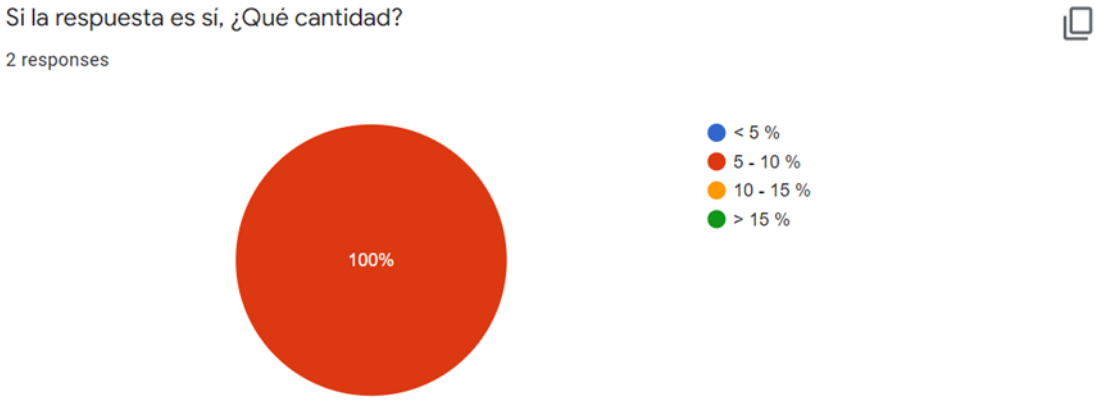
- biscuit flour for feed cost reduction effect.

If no, what is the reason?

1 response

Lack of continuous availability over time. Apprehension of the partners to the incorporation of new products, which may modify the characteristics of the resulting meat (colour, smell, etc.).





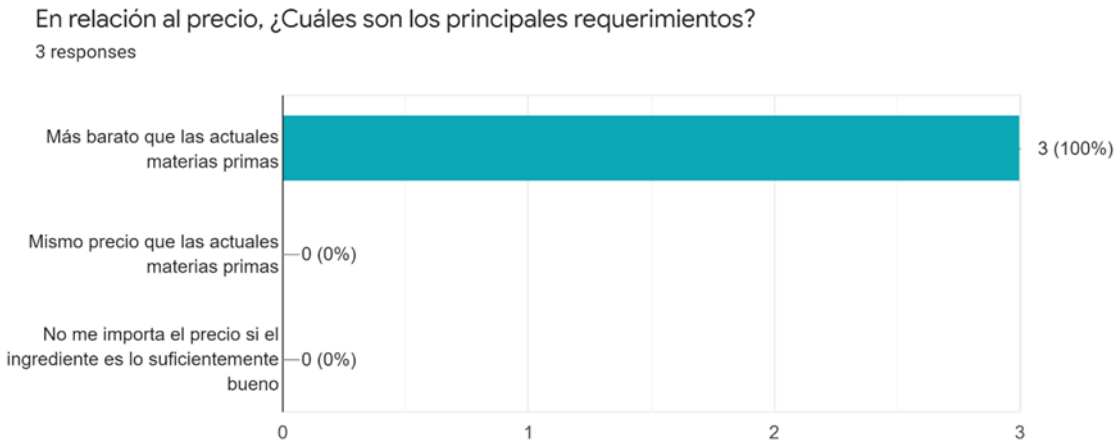
What are the main aspects to consider when including a new ingredient in the formulations?

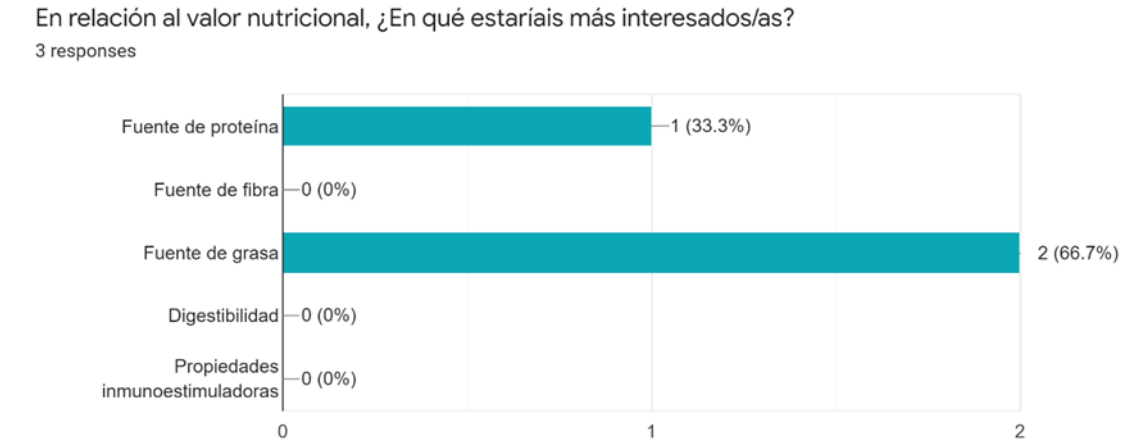
- The main problems are (from the smallest to the largest)
    - Sustainability
    - Food safety: hygienic conditions

- Consumer acceptance
- Origin-traceability
- Guarantees of supply and nutritional value
- Price

Do you identify any other problems when including a new ingredient in your formulations? Please specify 2 responses

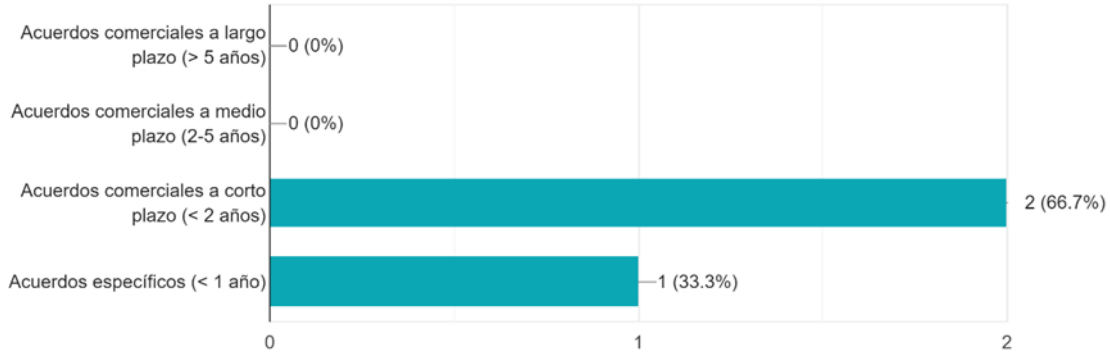
- Handling of the product in the factory
- Morphological alteration of the resulting meat. (either by change of colour, change in odour or taste)





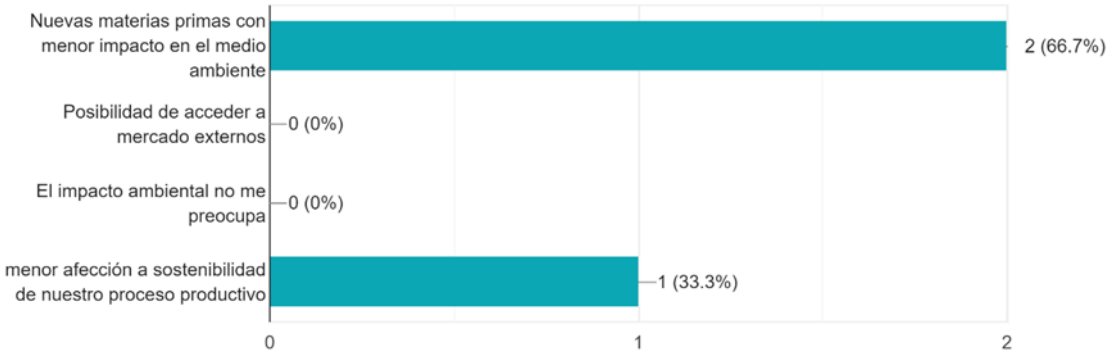
En relación con las garantías de suministro, ¿En qué estaríais más interesados/as?

3 responses



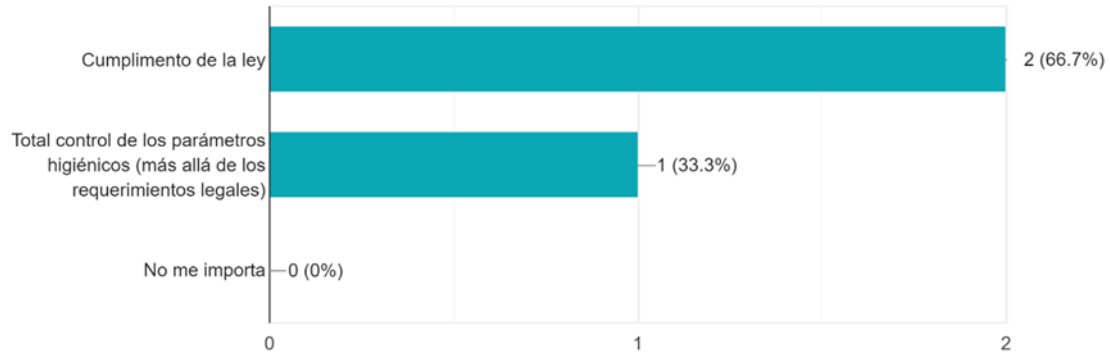
En relación a la sostenibilidad, ¿En qué estaríais más interesados/as?

3 responses



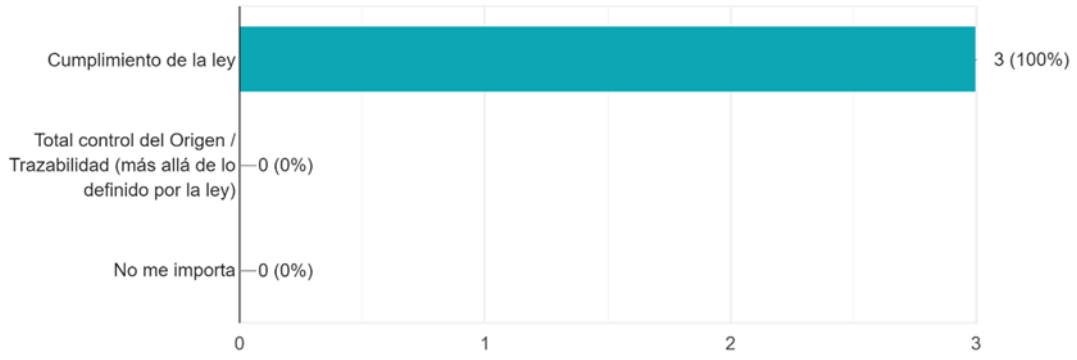
En relación a la seguridad alimentaria, ¿Cuáles son vuestros requerimientos?

3 responses



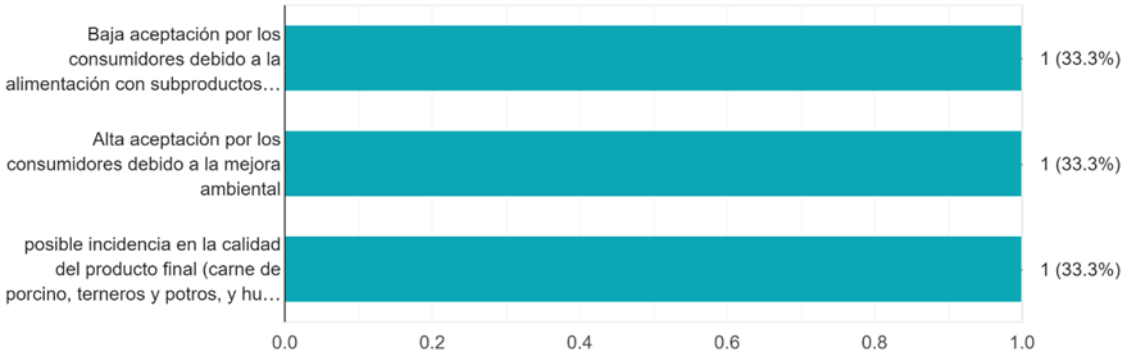
En relación con el origen / trazabilidad, ¿Cuáles son vuestros requerimientos?

3 responses



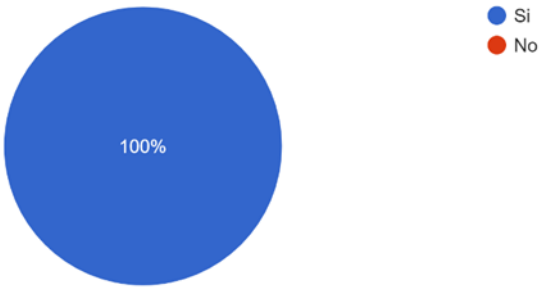
En relación con la aceptación por el consumidor, ¿Qué os preocupa?

3 responses



Si la respuesta es sí, ¿Estaríais dispuesto a pagar un sobre coste?

3 responses

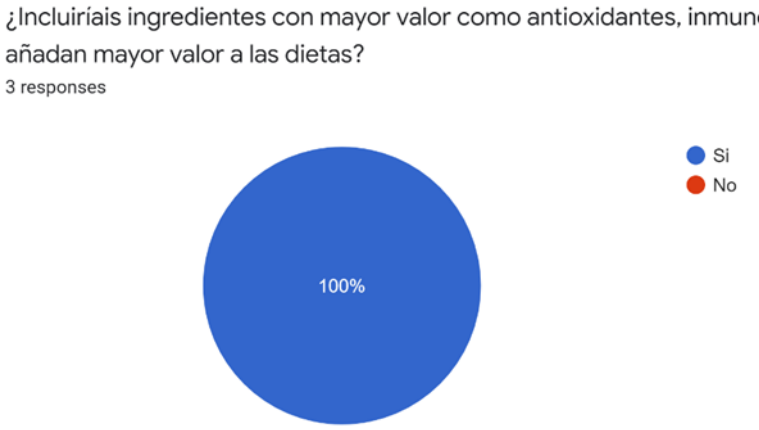


If yes, what are the reasons?

2 responses

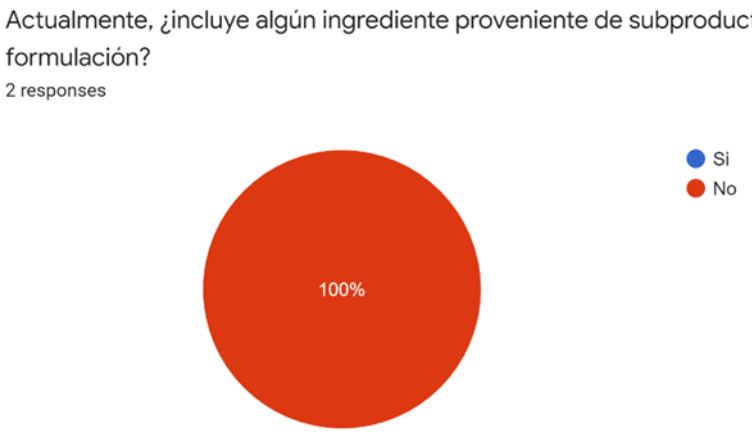
-Added value and differentiation

-Less consumption of medicines and longer time for the meat to be well present in the trays (vitamin E).



Livestock

Number of answers: 2

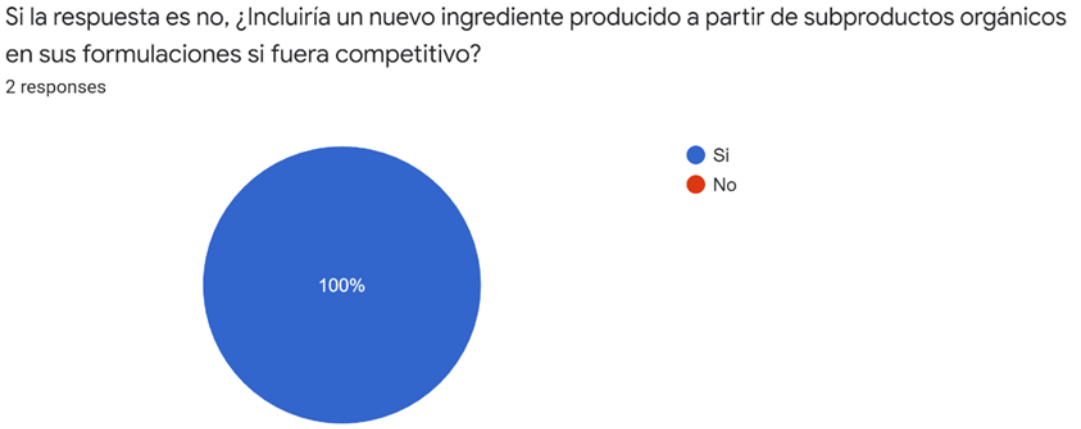


If the answer is no, what is the reason?

2 answers

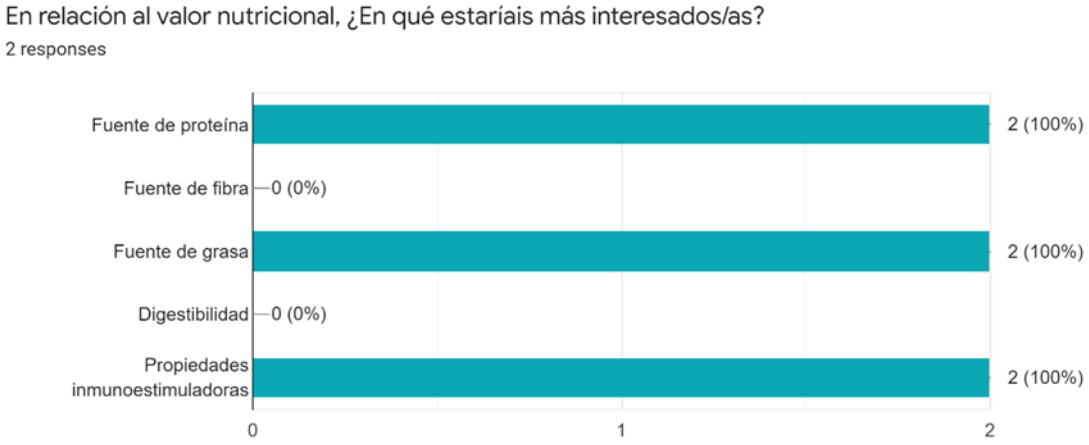
-I use little feed, I don't know if it has organic by-products.

-I don't know if it has by-products



-The main problems are (from the smallest to the largest)

- Sustainability
- Origin-traceability
- Food safety: hygienic conditions and guarantees of supply and nutritional value
- Consumer acceptance, Price, nutritional value

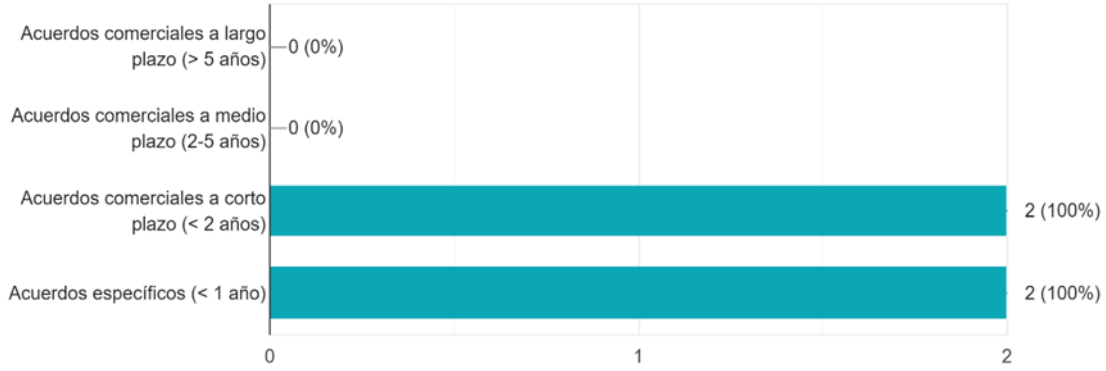


En relación al precio, ¿Cuáles son los principales requerimientos?

2 responses

En relación con las garantías de suministro, ¿En qué estaríais más interesados/as?

2 responses



En relación a la sostenibilidad, ¿En qué estaríais más interesados/as?

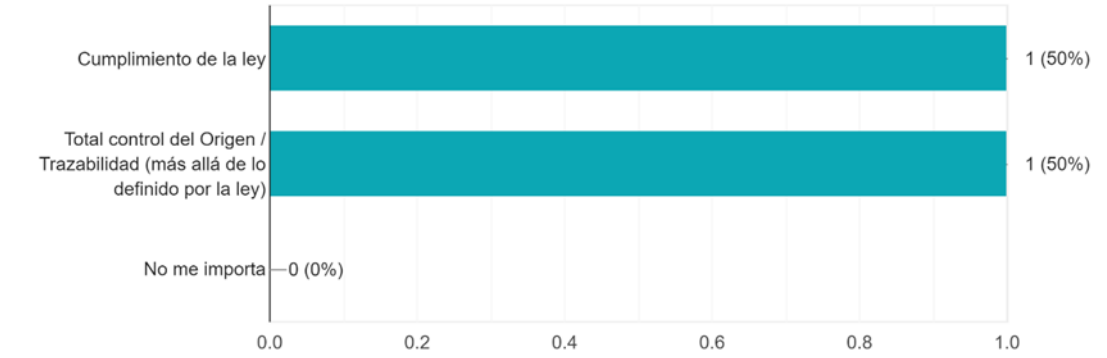
2 responses

En relación a la seguridad alimentaria, ¿Cuáles son vuestros requerimientos?

2 responses

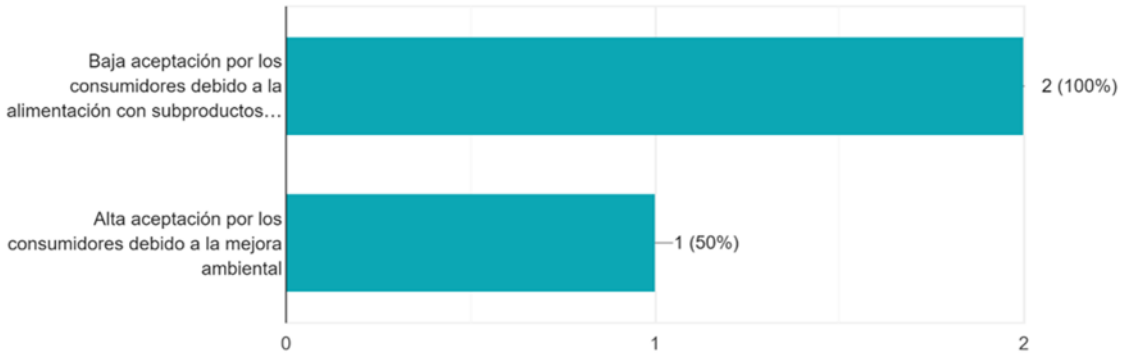
En relación con el origen / trazabilidad, ¿Cuáles son vuestros requerimientos?

2 responses



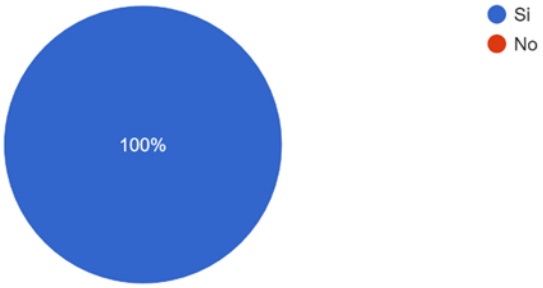
En relación con la aceptación por el consumidor, ¿Qué os preocupa?

2 responses



¿Incluirías ingredientes con mayor valor como antioxidantes, inmunoestimuladores, etc. que añadan mayor valor a las dietas?

2 responses



If yes, what are the reasons?

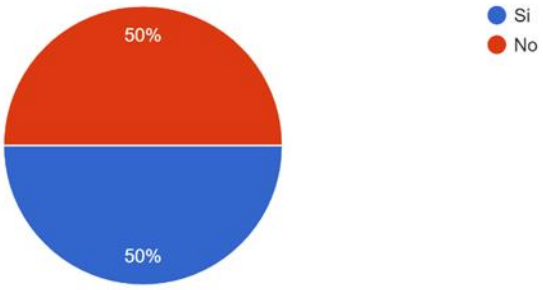
2 answers

-Because they are more valuable

-Because it has more value

Si la respuesta es sí, ¿Estarías dispuesto a pagar un sobre coste?

2 responses

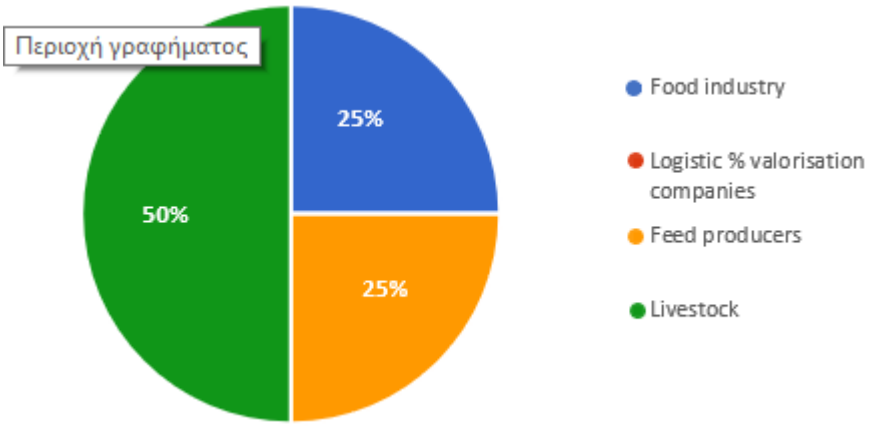


Questionnaire answers for case study 2

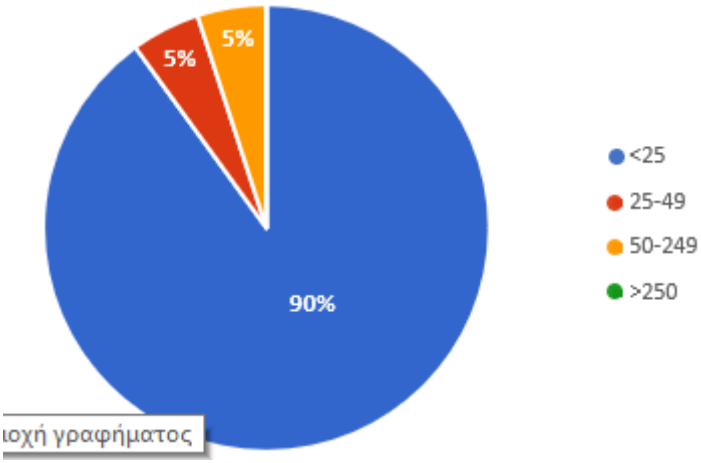
Το έργο NEWFEED έχει λάβει χρηματοδότηση από το πρόγραμμα PRIMA της Ευρωπαϊκής Ένωσης για Έρευνα, Τεχνολογική Ανάπτυξη και Επίδειξη βάσει της συμφωνίας-πλαισίου του 2013.

Number of answers: 20

Percentage of answers in each sector



Number of employees

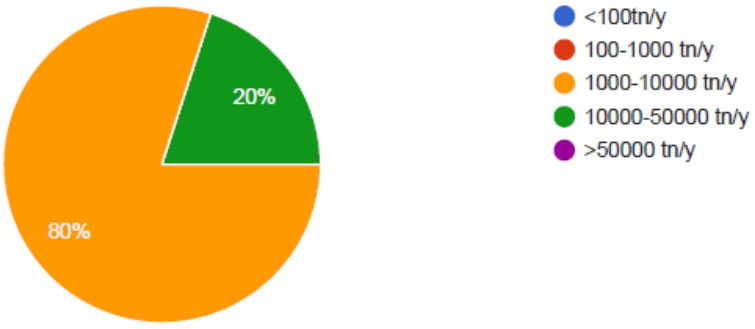


Food industry

Number of answers: 5

Ποια είναι η ετήσια παραγωγή φλοιών πορτοκαλιού;

5 responses



What is the annual orange peel production?

- 10000-50000 tn/y

- 1000-10000 tn/y

Είναι η παραγωγή του παραπροϊόντος εποχιακή;

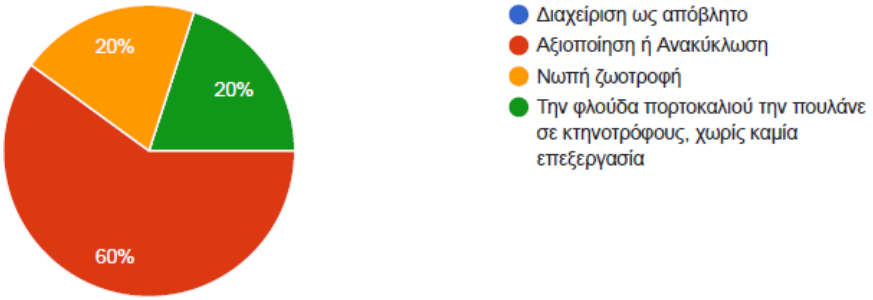
5 responses

Is the generation of your organic by-products seasonable?

- Throughout the whole year' s duration
- <3 months/year
- <9 months/year

Ποια είναι η τρέχουσα διαχείριση του παραπροϊόντος;

5 responses

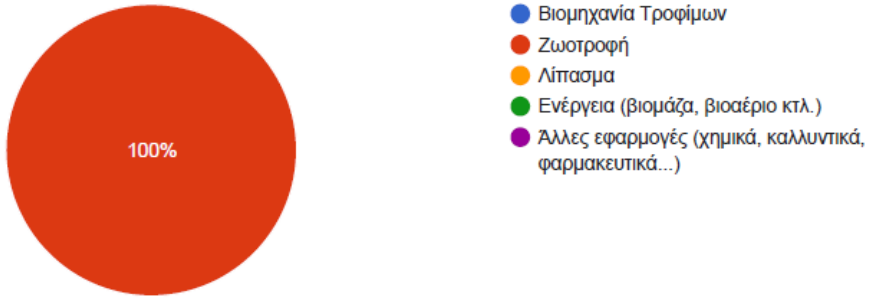


What is the current management practice of your by-product?

- In ascending order:
  - Fresh feed
  - Orange peel is sold to livestock farmers without any treatment
  - Valorisation/Recycling

Αν αξιοποιείτε τις φλούδες, σε ποια εφαρμογή προωθείται το νέο προϊόν;

5 responses

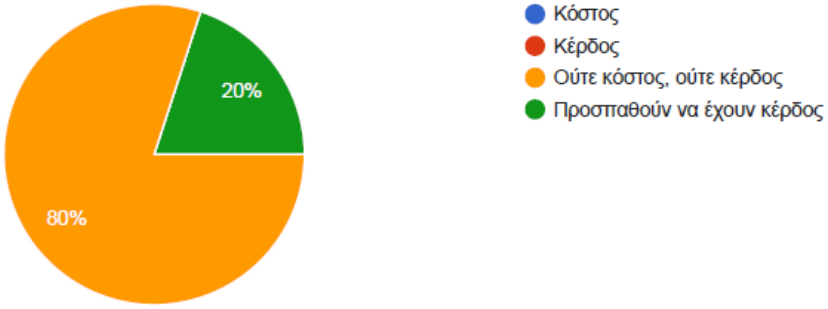


If it is valorised / recycled / reused, in which application?

- Animal feed

Πληρώνετε ή πληρώνεστε για τη διαχείριση των φλοιών πορτοκαλιού;

5 responses

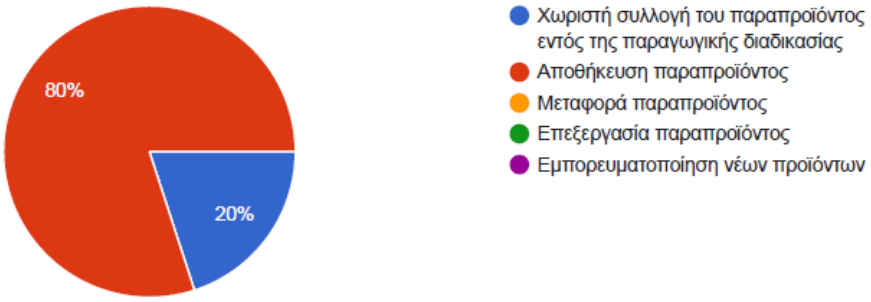


Do you pay or charge for its management?

- In ascending order:
    - Trying to make out profit
    - Neither cost nor profit

Ποια είναι τα κύρια προβλήματα που αντιμετωπίζετε στη διαχείριση του παραπροϊόντος;

5 responses

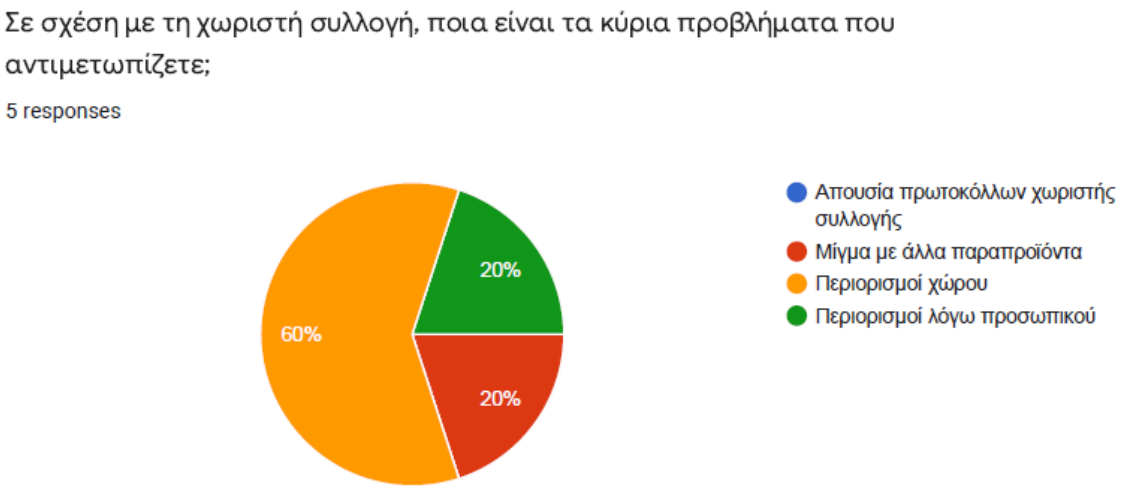


Which are the main problems that you face in the management of the by-product?

- In ascending order:
    - The separate collection of the by-product within the production line
    - The by-product' s storage

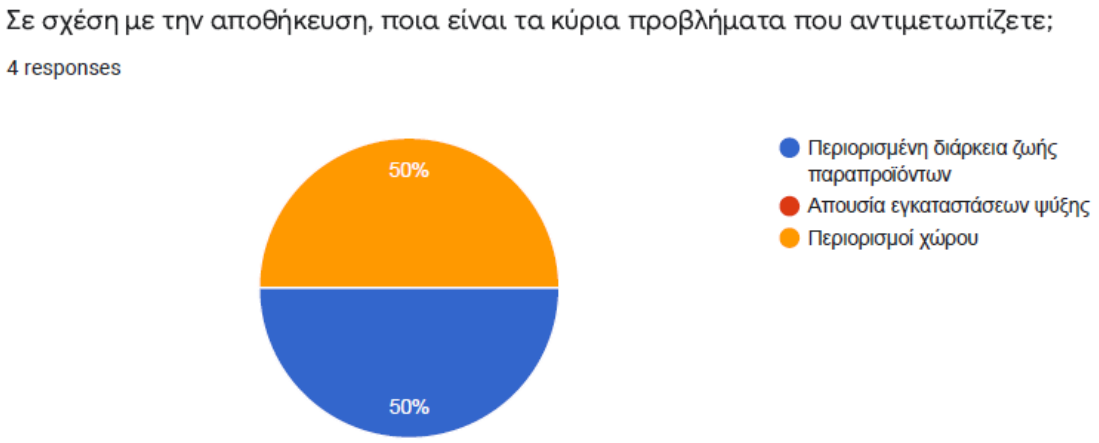
Logistic and processing

Number of answers: 5



In relation to Separation in origin, which are your main problems?

- In ascending order:
    - Personnel limitations
    - Mixture with other by-products
    - Space limitations

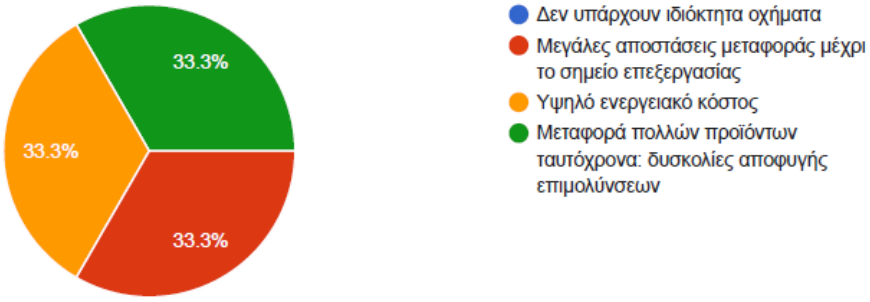


In relation to Storage, which are your main problems?

- Space limitations
- Limited by-product shelf life

Σε σχέση με τη μεταφορά, ποια είναι τα κύρια προβλήτα που αντιμετωπίζετε;

3 responses



In relation to Transportation, which are your main problems?

- High energy cost
- Long transportation distance to the processing plant
- Multi-product transportation: difficulties to avoid cross contamination

Σε σχέση με την επεξεργασία, ποια είναι τα κύρια προβλήματα που αντιμετωπίζετε;

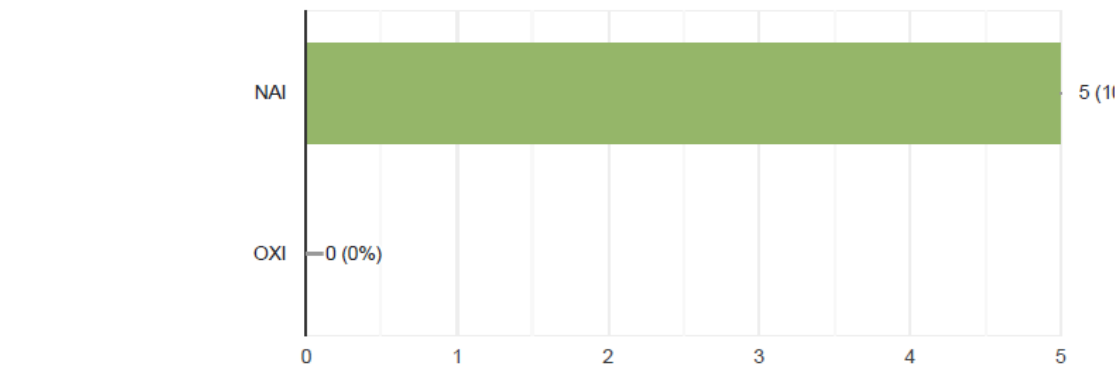
4 responses

In relation to Processing, which are your main problems?

- In ascending order:
    - High energy cost
    - Absence of adequate technologies
    - High investment cost

In relation to Commercialization, which are your main problems?

- In ascending order:
    - Currently there are no significant commercialization issues
    - Lack of market knowledge
    - The by-product has no value

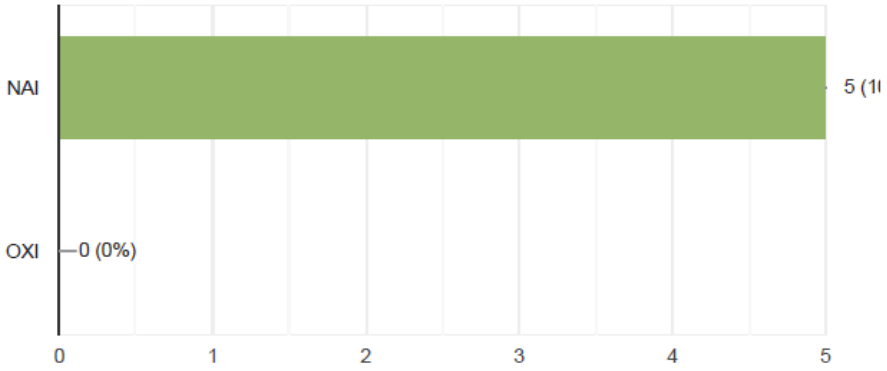


Would you be interested in a technology solution to valorise your organic by-products for animal feed?

- Yes

Θα θέλατε η ομάδα του NEWFEED να σας προσφέρει μια προσαρμοσμένη λύση για την εταιρεία σας;

5 responses



Would you like the NEWFEED team to provide you a tailored treatment solution for your company?

- Yes

Παρακαλώ δώστε οποιεσδήποτε πρόσθετες πληροφορίες θεωρείτε ενδιαφέρουσες.

2 responses

Τα τελευταία χρόνια εφαρμόζεται η τεχνική της ενσήρωσης και όχι η ξήρανση του παραπροιόντος.

Θα μιλήσουμε τηλεφωνικά 6947209469 Σωτ.Ματράγκος

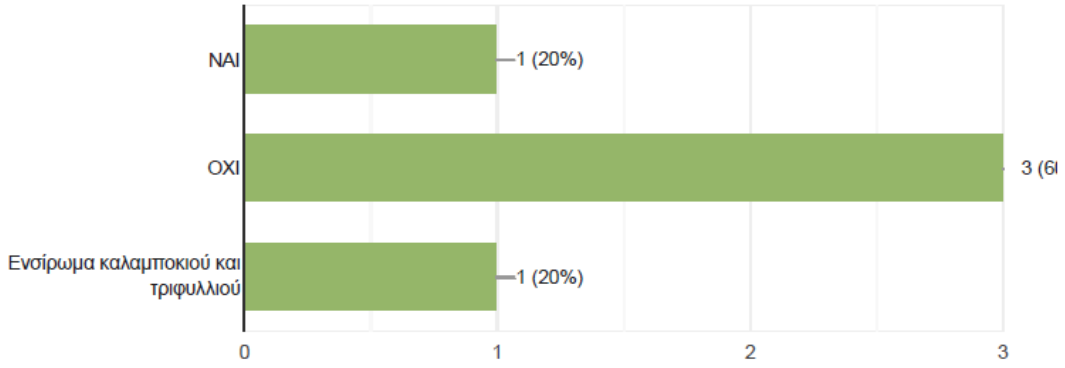
Any information you can consider interesting.

Feed industry

Number of answers: 5

Χρησιμοποιείτε κάποιο οργανικό παραπροϊόν ως συστατικό στις ζωοτροφές που παράγετε;

5 responses

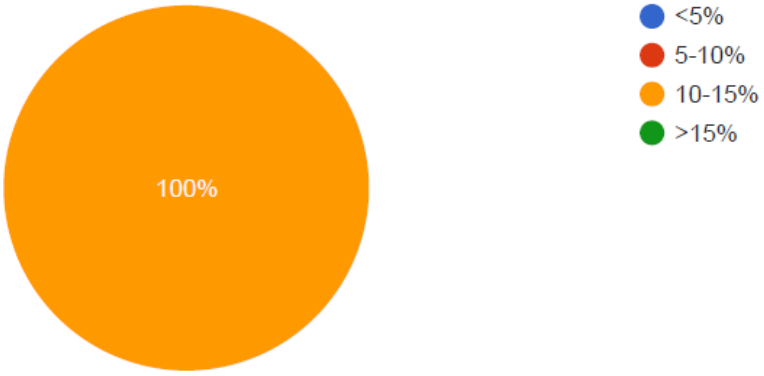


Do you currently include any organic by-product as an ingredient in the formulation?

- In ascending order:
    - Yes
    - Corn and alfalfa silage
    - No

Αν ναι σε ποια ποσότητα και ποιο;

1 response



If yes, in what amount?

- 10-15 %

Αν όχι, ποιός είναι ο λόγος;

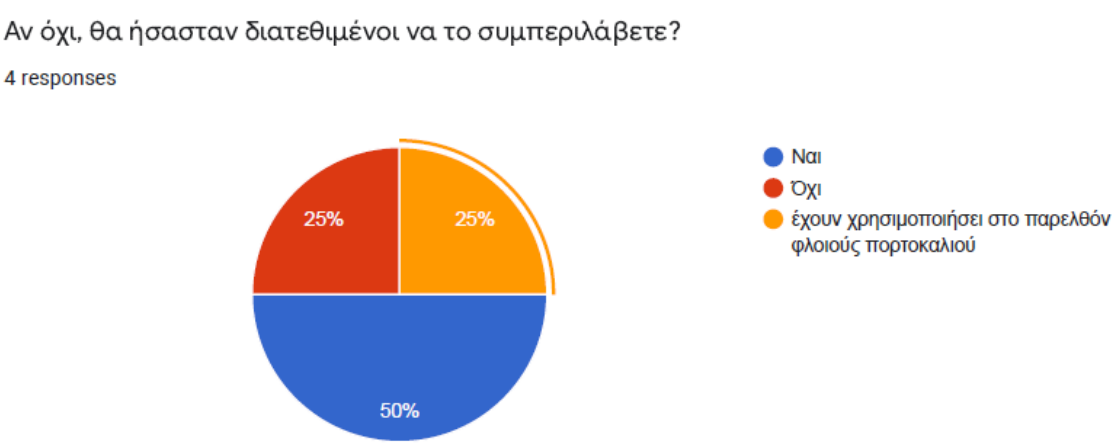
2 responses

Είναι δύσκολο να ενταχθεί ένα νέο συστατικό στις ζωοτροφές και αυτό οφείλεται στη λειτουργία των μηχανημάτων της βιομηχανίας.

ΔΕΝ ΕΧΕΙ ΖΗΤΗΘΕΙ ΑΠΟ ΠΕΛΑΤΕΣ

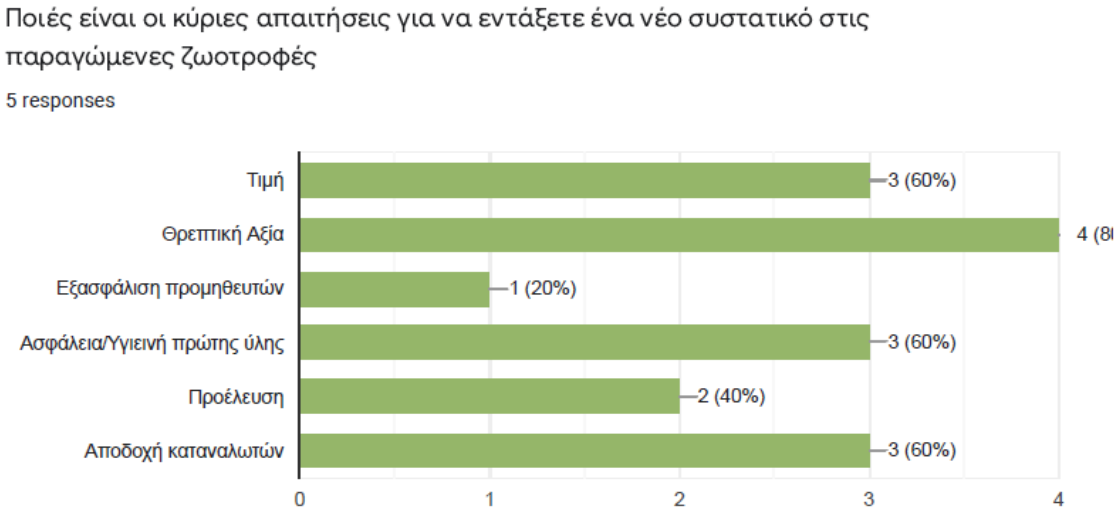
If not, which is the reason?

- It is hard for a new ingredient to be incorporated in feed and this is due to the operation of the industrial equipment
- It has not been requested by customers



If not, would you include a new ingredient produced from organic by-products in your diets?

- In ascending order:
    - In the past, they have used orange peel
    - No
    - Yes

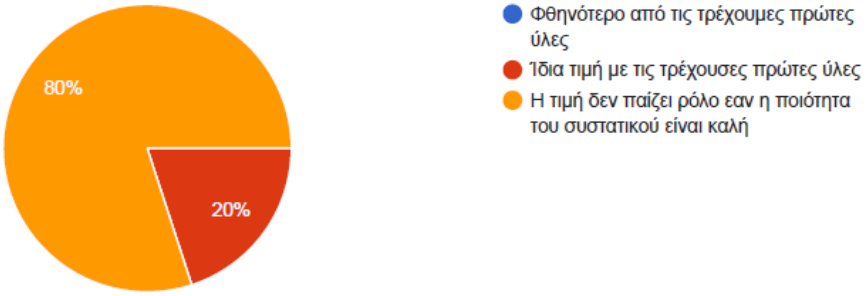


What are the most important requirements when integrating a new ingredient in your formulations?

- In ascending order:
    - Supply guarantees
    - Origin
    - Price
    - Hygiene/Food safety
    - Consumer acceptance
    - Nutritional value

Σε σχέση με την τιμή, ποιές είναι οι κύριες απαιτήσεις;

5 responses

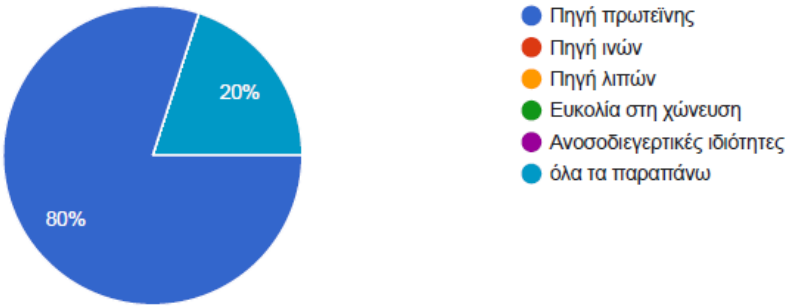


In relation to price, what are your requirements?

- In ascending order:
    - Same price with the currently used raw material
    - Price doesn’ t play role, if the quality of the ingredient is fine

Σε σχέση με τη διατροφική αξία, τι θα σας ενδιέφερε;

5 responses



In relation to Nutritional Value, what are your requirements?

- In ascending order:
    - All of the above
    - Protein source

Σε σχέση με την εξασφάλιση των προμηθευτών, τι είδους συμφωνία θα σας ικανοποιούσε;

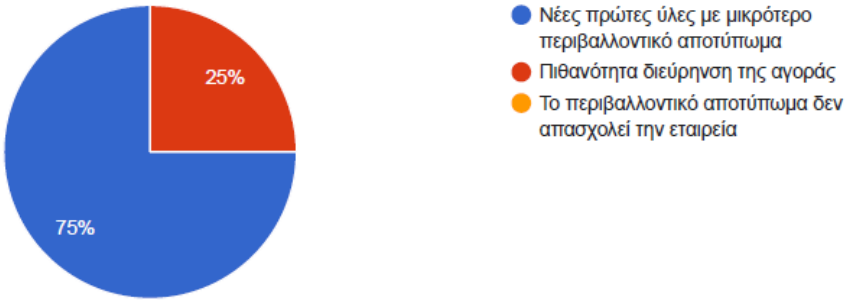
5 responses

In relation to Supply Guaranties, what would you be interested in?

- Special agreements (< 1 year)

Σε σχέση με την αειφορία, τι θα σας ενδιέφερε περισσότερο;

4 responses



In relation to Sustainability, what you be interested in?

- In ascending order:
    - A possibility of market expansion
    - A new raw material with a smaller environmental footprint

Σε σχέση με την ασφάλεια/υγιεινή της νέας πρώτης ύλης, ποιές είναι οι απαιτήσεις;

5 responses

In relation to Hygiene/Food Safety, what are your requirements?

- In ascending order:
  - Compliance with legislation
  - Full control of the food safety parameters (beyond what legislation requires)

In relation to Origin, what are your requirements?

- In ascending order:
  - Compliance with legislation
  - Hygiene/Food Safety is not one of the company' s concerns
  - Full control of the food safety parameters (beyond what legislation requires)

In relation to consumer acceptance, what would be your concerns?

- In ascending order:
  - Consumer acceptance relates to the product' s nutritional value and price
  - Small acceptance due to the fact that the raw material is derived from food waste

Εχέτε κάποιες άλλες απαιτήσεις ή/και ανησυχίες σε σχέση με τη χρήση της νέας πρώτης ύλης;

2 responses

Οχι

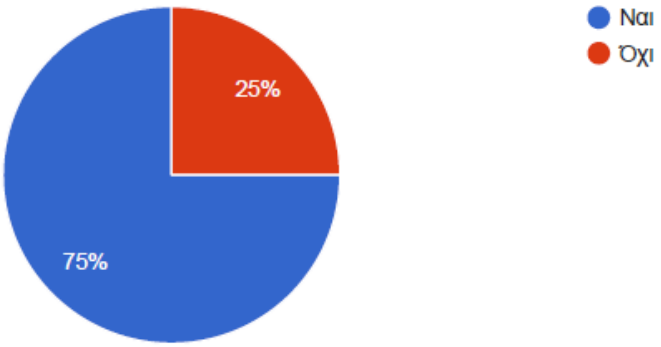
ΟΧΙ

Do you have any other requirements/concerns regarding the new raw material' s use?

- No
- No

Η προσθήκη εμπλουτισμένων συστατικών όπως αντιοξειδωτικών, ανοσοδιεγερτικών κ.α. προσθέτει αξία στην τελική ζωοτροφή;

4 responses



Would the inclusion of enriched ingredients such as antioxidants, inmunoestimulatories, etc. add value to the final feed?

- Yes
- No

Παρακαλώ δώστε οποιεσδήποτε πρόσθετες πληροφορίες θεωρείτε ενδιαφέρουσες.

1 response

Χρησιμοποιούν ενσίρωμα καλαμποκιού στις ζωοτροφές τους.

Any information you can consider interesting.

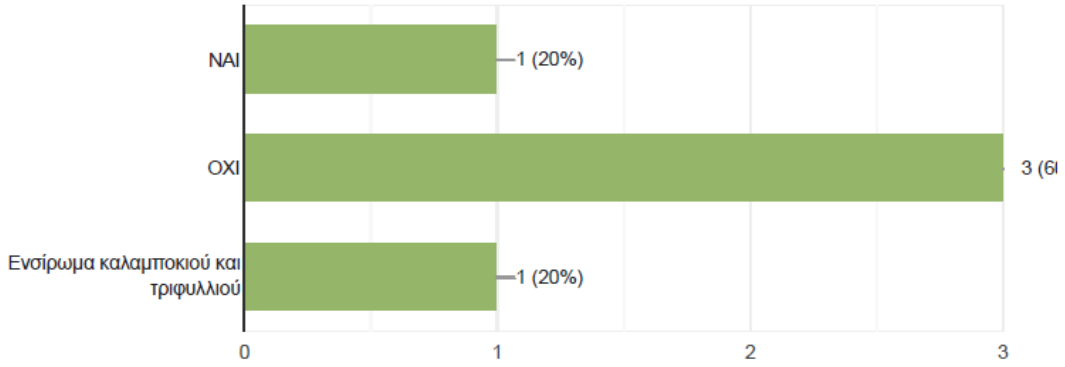
- We use corn silage in our animal feeds.

Livestock

Number of answers: 10

Χρησιμοποιείτε κάποιο οργανικό παραπροϊόν ως συστατικό στις ζωοτροφές που παράγετε;

5 responses

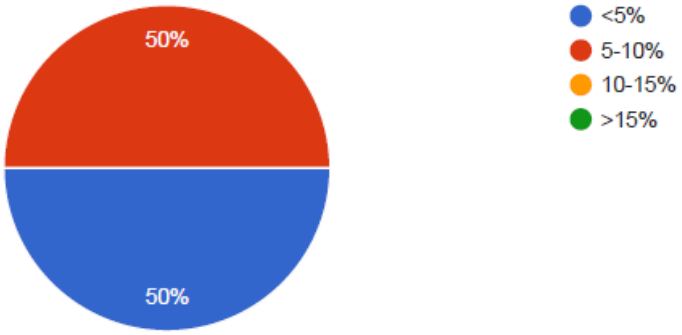


Do you currently include any organic by-product as an ingredient in the formulation?

- In ascending order:
    - Yes
    - Corn and alfalfa silage
    - No

Αν ναι σε ποια ποσότητα και ποιο;

6 responses



If yes, in what amount?

- < 5 %
- 5-10 %

Αν όχι, ποιός είναι ο λόγος;

3 responses

Δεν μου πρωταθηκε κάποιο.

Διαθεσιμότητα

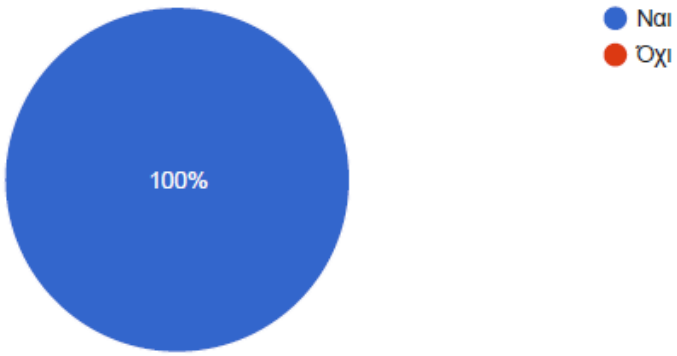
Μικρή διαθεσιμότητα

If the answer is no, what is the reason?

- Nobody has suggested the inclusion of a new ingredient to me
- The availability
- Small availability

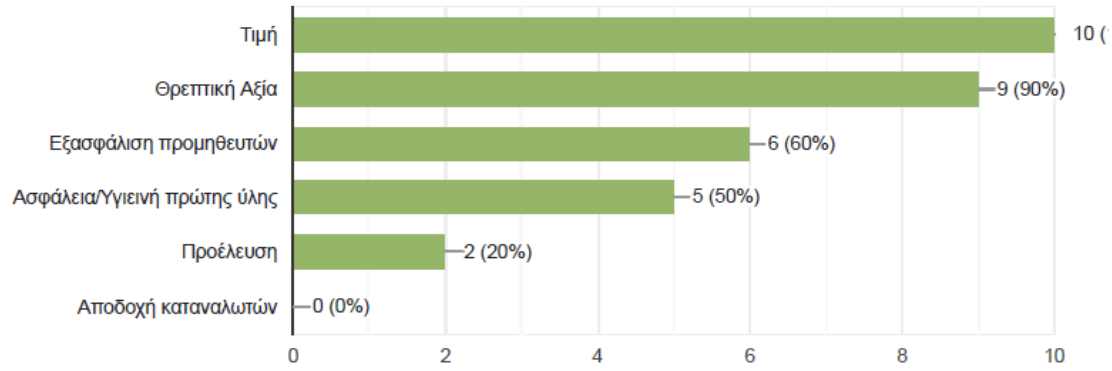
Αν όχι, θα ήσασταν διατεθιμένοι να το συμπεριλάβετε?

5 responses



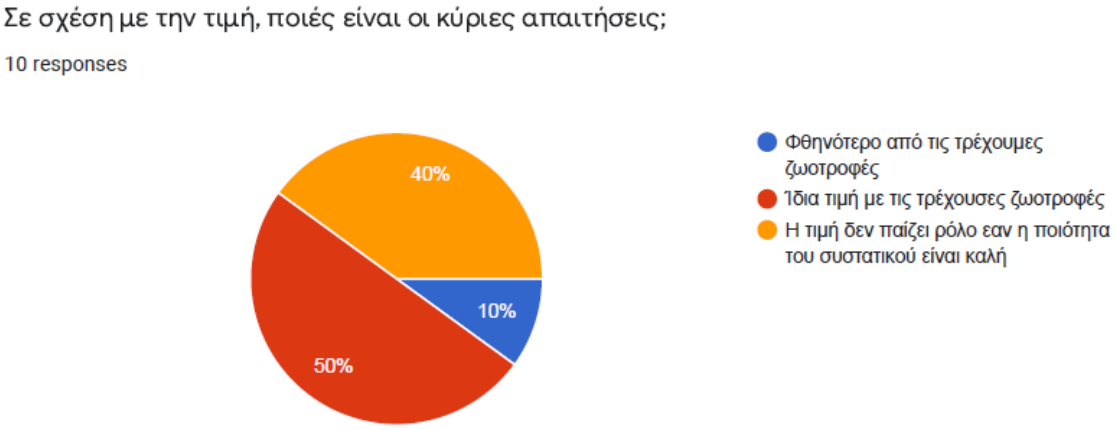
If not, would you include a new ingredient produced from organic by-products in your diets?

- Yes



What are the most important requirements when integrating a new ingredient in your formulations?

- In ascending order:
    - Consumer acceptance
    - Origin
    - Hygiene/Food safety
    - Supply guarantees
    - Nutritional value
    - Price

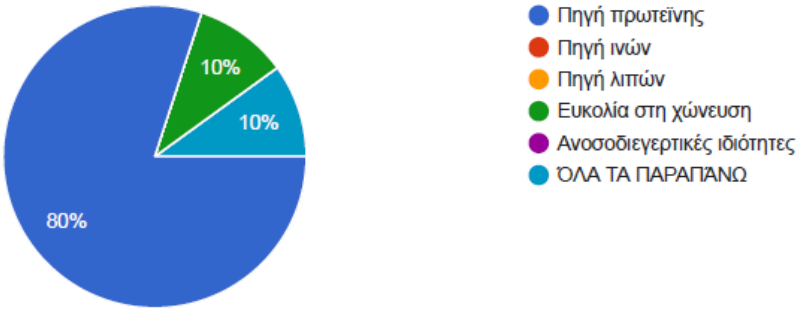


In relation to Price, which are your main requirements?

- In ascending order:
    - Cheaper than the currently used animal feed
    - Price doesn’ t play role, if the quality of the ingredient is high
    - Same price with the currently used animal feed

Σε σχέση με τη διατροφική αξία, τι θα σας ενδιέφερε;

10 responses



In relation to Nutritional Value, what would you be interested in?

- In ascending order:
    - All of the above
    - Easily digestible
    - Source protein

Σε σχέση με την εξασφάλιση των προμηθευτών, τι είδους συμφωνία θα σας ικανοποιούσε;

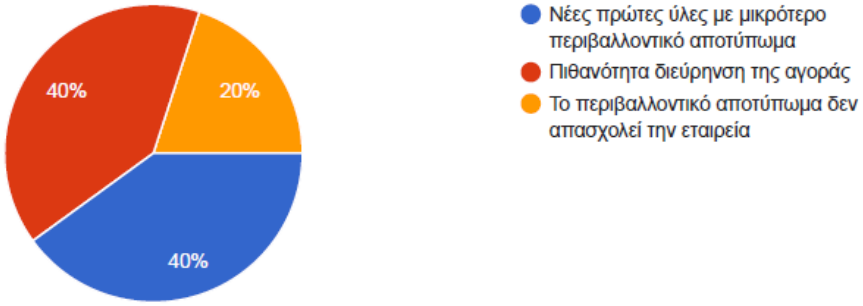
10 responses

In relation to Supply Guaranties, what would you be interested in?

- In ascending order:
    - Mid-term commercial supply agreement (2-5 years)
    - Short-term commercial supply agreement (< 2 years)
    - Special Agreements (< 1 year)

Σε σχέση με την αειφορία, τι θα σας ενδιέφερε περισσότερο;

10 responses



In relation to Sustainability, what would you be interested in?

- In ascending order:
    - Environmental footprint is not one of company' s concerns
    - The possibility of a market expansion
    - New raw materials with a smaller environmental footprint

Σε σχέση με την ασφάλεια/υγιεινή της νέας πρώτης ύλης, ποιές είναι οι απαιτήσεις;

10 responses

In relation to Hygiene/Food Safety, what are your requirements?

- In ascending order:
    - Compliance with legislation
    - Full control of the food safety parameters (beyond what legislation requires)

Σε σχέση με την προέλευση της πρώτης ύλης, ποιές είναι οι απαιτήσεις;

10 responses

In relation to Origin, what are your requirements?

- Full control of the food safety parameters (beyond what legislation requires)
- Compliance with the legislation

Σε σχέση με την αποδοχή των καταναλωτών, ποιές είναι οι κύριες ανησυχίες σας;

9 responses

In relation to Consumer acceptance, what would be your concerns?

- In ascending order:
    - Small acceptance due to the fact that the raw material is derived from food waste
    - High acceptance due to environmental concerns

Εχέτε κάποιες άλλες απαιτήσεις ή/και ανησυχίες σε σχέση με τη χρήση της νέας πρώτης ύλης;

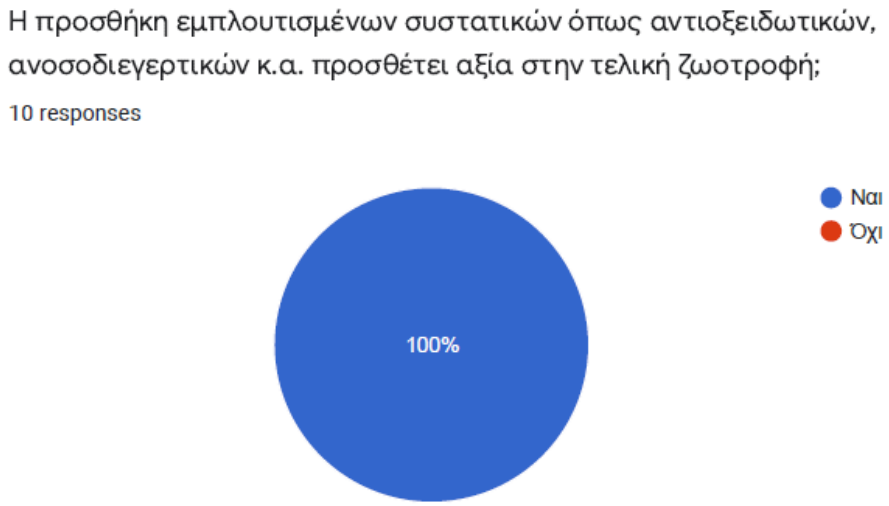
2 responses

Να προάγει την υγεία και την παραγωγικοτητα των ζωων

Οι βασικές ανησυχίες μας πηγάζουν απο το γεγονός ότι στην Ελλάδα πολύ λίγοι προμηθευτές έχουν πιστοποιημένα προιόντα ως προς την ποιότητα, την διατροφική αξία και την διαδικασία παραγωγής τους, όπως επίσης και την αποφυγή ανάληψης ευθύνης στην περίπτωση που διαπιστωθούν προβλήματα στις ζωοτροφές (αφλατοξίνες, επιβλαβείς ουσίες απο ραντίσματα, λιπάσματ, κλπ) που μπορούν να επηρρεάσουν την υγεία και την απόδοση των παραγωγικών ζώων.

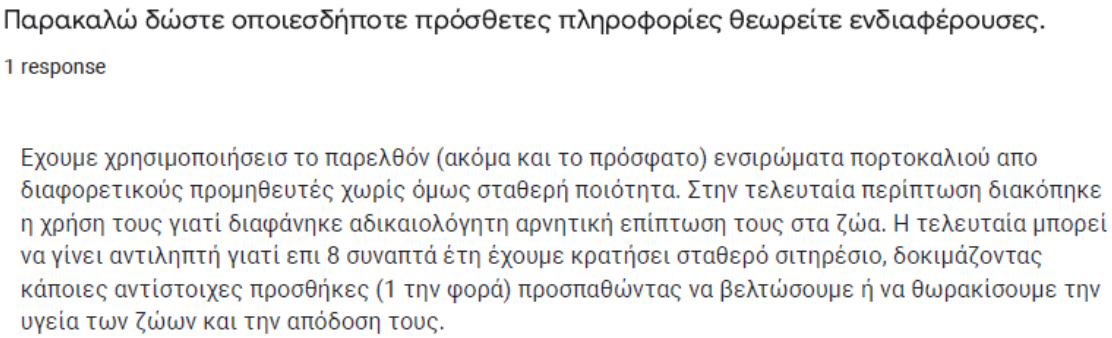
If you have selected Other requirements, what would be your concerns?

- To promote animals' health and productivity
- Our main concerns come from the fact that in Greece very few suppliers provide certified products that regard to the quality, the nutritional value and the production process, as well as the attitude of avoiding taking the respective responsibility in case problems occur that could possibly affect the health and the efficiency of productive animals.



Would the inclusion of enriched ingredients such as antioxidants, inmunoestimulatories, etc. add value to the final feed?

- Yes



Any information you can consider interesting.

- We have used in the past, even at the most recent one, orange silages from different suppliers, but with no constant quantity characteristics. On the last case, their use was stopped because there was noted an inexcusably negative impact on animals. The impact was more than obvious, since throughout 8 consecutive years, we have managed to keep a constant diet, making trials with respective additives (one at a time) in our effort to promote or secure the animals' health and efficiency.

Questionnaire answers for case study 3

NEWFEED Project Questionnaire

The overall objective of the project is to develop and adopt alternative animal feeds, setting up a circular economy approach in the livestock production by turning food by-products into high value secondary feedstuff for animal feed.

The purpose of this survey is to identify hurdles and bottlenecks of 3 specific whole value chains (from raw materials to consumers) to enable the use of these alternative raw materials as secondary feedstuffs for feed. These three value chains are:
1)Use of grape stem from wineries for dairy sheep and cattle
2) Use of orange peel from orange juice industries for dairy sheep and
3) Use of olive cake form olive oil industry by-products for poultry.

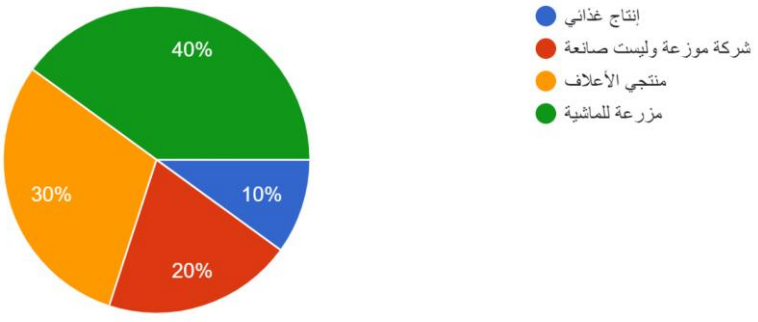
The analysis of obtained data will detect hurdles and bottlenecks that prevent the full implementation of valorisation solutions, as well as the description of success stories in the valorisation of by-products to be used as animal feed.

Three value chains at the Mediterranean area will be validated to create new business opportunities based on a multi-actor approach in their conception, configuration, and its sustainability assessment:
• The 1st case study will assess the use of grape stem from wineries as a second-generation feedstuff to produce a new feed ingredient for ruminants (dairy sheep and cattle). This case study is led by AZTI and tested in Spain.
• The 2nd case study will assess the use of orange peel from orange juice industry to produce an improved feed ingredient for ruminants (dairy sheep). This case study is led by NTUA and tested in Greece.
• The 3rd case study will assess the use of olive cake from olive oil industry to produce an improved feed ingredient for poultry (broiler chicken). This case study is led by HUSD and tested in Egypt.

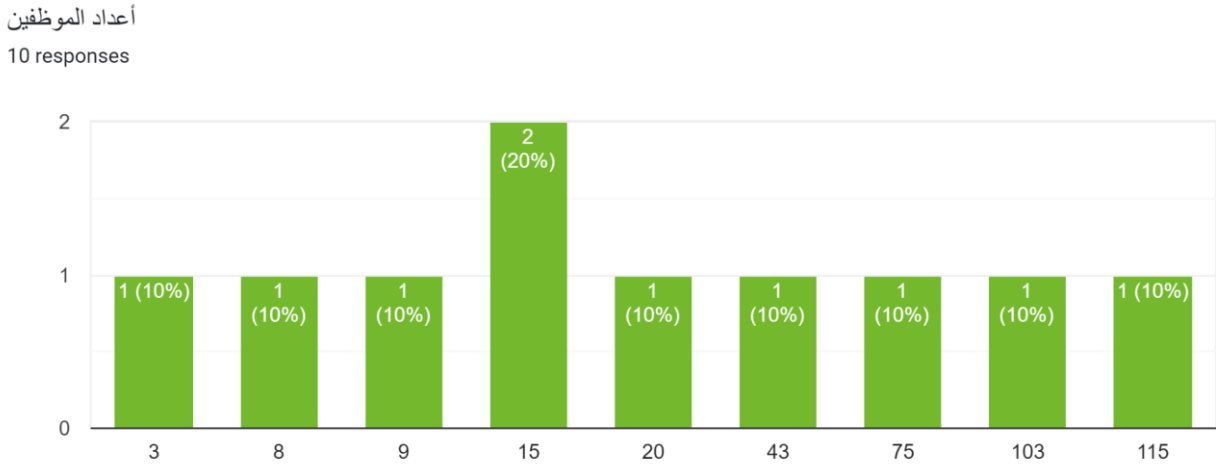
10 participants in this survey:

- Food industry (1)
- Logistic and valorisation companies (5)
- Livestock (4)

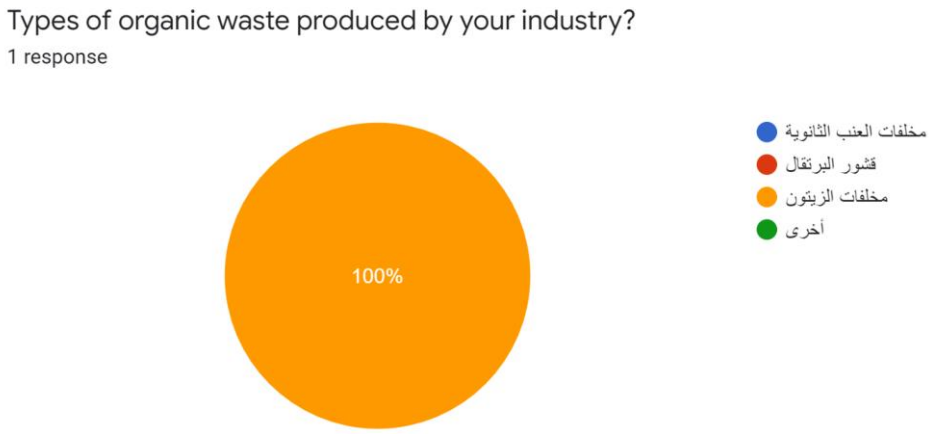
company category
10 responses



Number of employees: between 3 to 120 employees.



Food industry

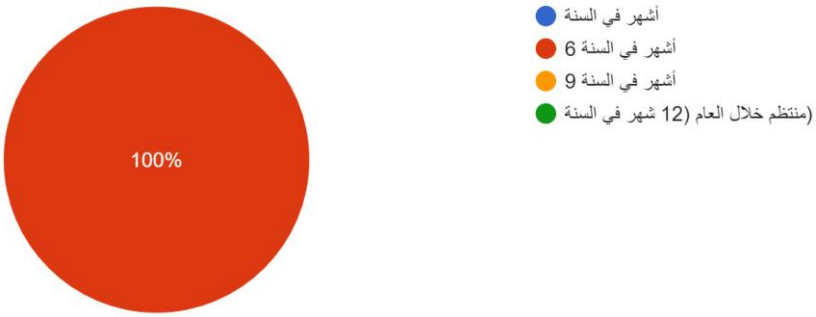


What is the amount of organic waste produced by your industry?

1 response

Are these organic waste produced seasonally?

1 response



If it is recycled, reused or increased in value, what is the method used for that?

1 response

What is the current approach to how to use this organic waste?

1 response

Main important aspects:

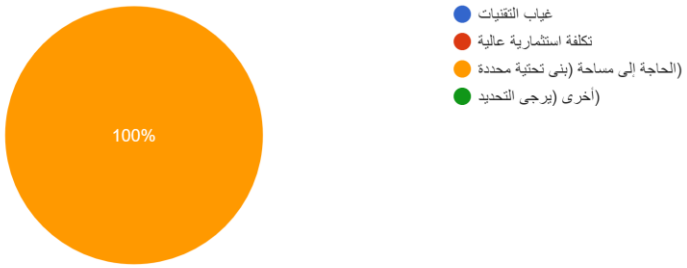
- There is income for collecting the waste. While managing waste storage is the main issue.
- Due to lack of space. There are no private trucks to transport the waste on a regular basis.

What are the most important problems you face when managing this organic waste?

1 response

With regard to the treatment of this waste, what are the most important problems that you face?

1 response



With regard to transportation, what are the most important problems you face?

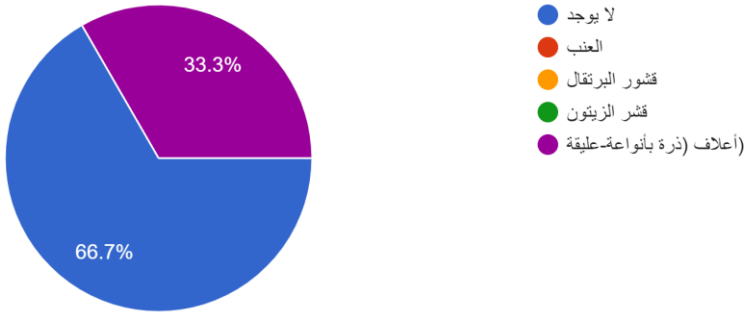
1 response

Logistic & valorisation companies

- 2 participants are distributing company
- none 66 %, animal feed 33 %.
- lack of storage

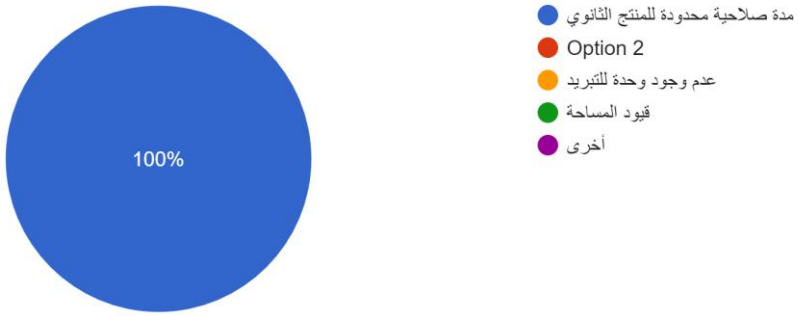
What are the types of food factory waste that it collects or works to increase its value?

3 responses



With regard to storage, what is the main problem you face?

2 responses

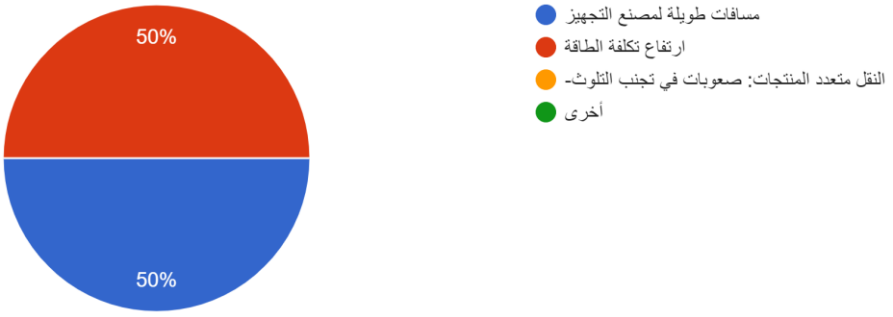


Main important aspects:

- Long distance, High prices of the transportation
- Lack of space, lack of technology
- Lack of knowledge of these alternative

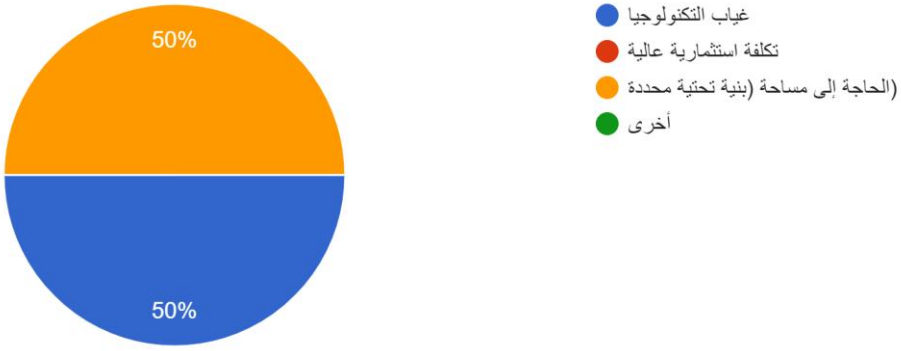
With regard to transportation, what is the main problem you face?

2 responses



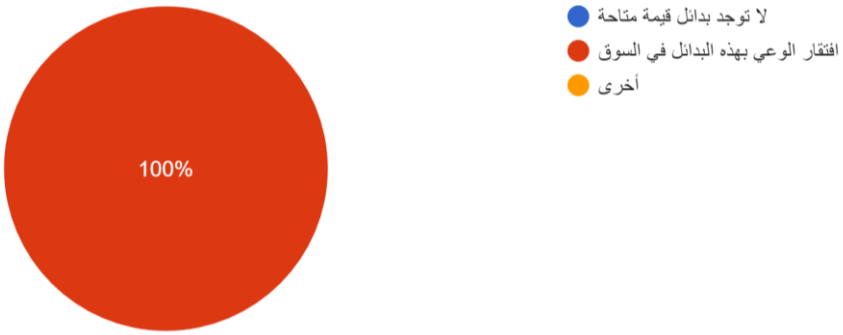
With regard to manufacturing, what is the main problem you face?

2 responses



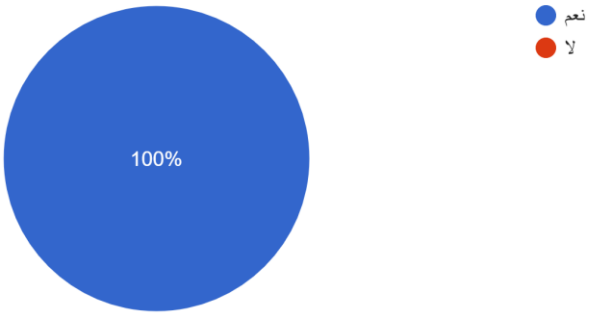
In terms of marketing or promotion, what is the main problem you face?

2 responses



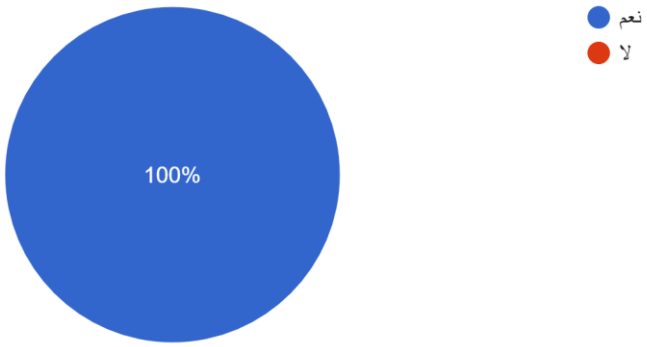
Are you interested in finding an alternative technology solution to increase the value of organic by-products for animal feed?

2 responses



Would you like the NEWFEED team to offer you a customized solution for your business?

2 responses



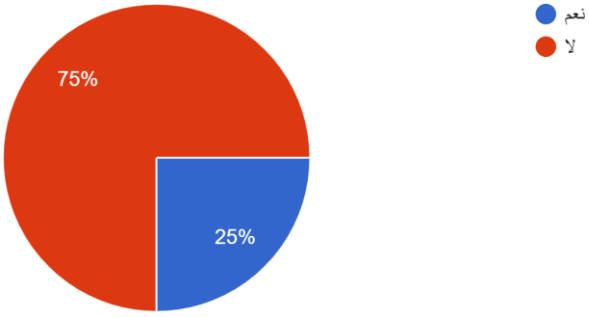
Reasons behind that:

- Reducing the cost - increasing the profit - the possibility of establishing a small factory

Livestock

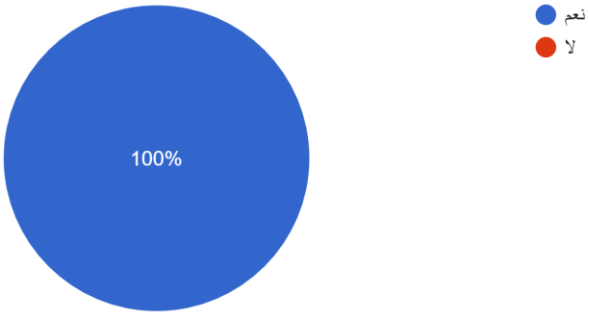
Do you currently include any organic by-product as an ingredient in your formulation?

4 responses



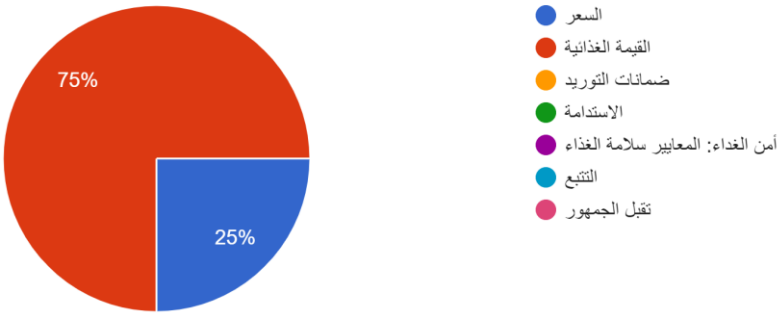
If not, will you include a new ingredient that is produced from organic by-products in your diets?

4 responses



What are the most important requirements when incorporating a new ingredient into your formulations?

4 responses



Main important aspects:

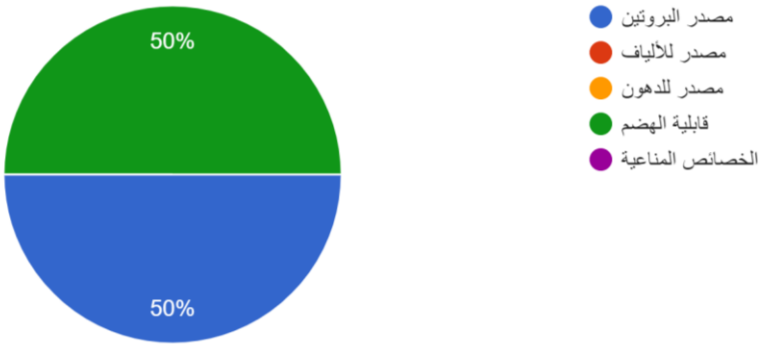
- Less than 2 years 25 %, less than 1 year 25 %, between 5-2 years 50 %
- Protein 50 %, digestible 50 %
- Expand in market 25 %, sustainability is not my concerns 75 %.

In terms of guarantees of supply, what might you be interested in?

4 responses

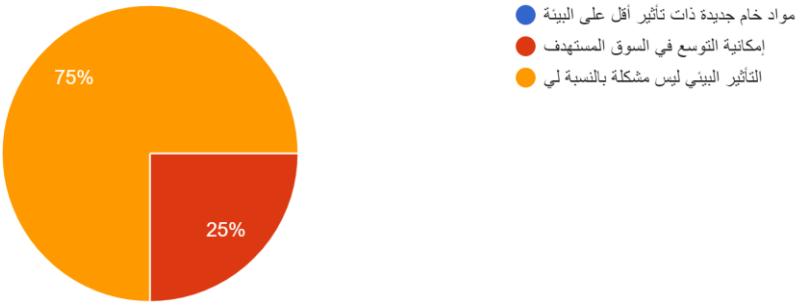
In terms of nutritional value, what might you be interested in?

4 responses



In terms of sustainability, what might you be interested in?

4 responses



Regarding food safety, what are your requirements?

4 responses

In terms of consumer acceptance, what are your concerns?

4 responses