PROJECT FINAL REPORT

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Project acronym: BANUS

Project title: DEFINITION AND DEVELOPMENT OF FUNCTIONAL BARRIERS FOR THE USE OF RECYCLED MATERIALS IN MULTILAYER FOOD PACKAGING

Funding Scheme: Research for the Benefit of SMEs

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[2] The home page of the website should contain the generic European flag and the FP7 logo which are available in electronic format at the Europa website (logo of the European flag: http://europa.eu/abc/symbols/emblem/index_en.htm ; logo of the 7th FP: http://ec.europa.eu/research/fp7/index_en.cfm?pg=logos). The area of activity of the project should also be mentioned.

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1. Final publishable summary report

1.1. Executive summary

The global expected results of **BANUS** project is *to increase the technological knowledge about technologies and materials to develop **new multilayer packages with functional barrier properties for food contact applications**, in order to include **recycled materials** in their structures, and then to be able to increase EU **industry competitiveness** from the low cost labour countries.*

BANUS project implies a great deal of innovation in the field of functional barriers because it proposes technical advances in each one of the three proposed cases studies:
- Case Study 1: **Semi-rigid multilayer plastic packaging** (PP/EVOH/PP)
In this case the recycled material will be PP, and the proposed functional barrier is EVOH/PP. The performance of the structure (EVOH/PP) as functional barrier is not so well known. It is also interesting to study the performance of these kind of structure because it is widely used in the market.
- Case Study 2: **Flexible multilayer multimaterial packaging** (Paper/PET met/PE)
In this case the recycled material will be paper, and the proposed functional barrier is PET met/PE. All the relevant bibliography found studies the performance of PET as a functional barrier in multilayer plastic structures, mainly with multilayer PET structures (PET/Recycled PET/PET). Paper and paperboard have different implications related to recycling than plastics, so this study is considered as an advance beyond the state-of-the-art.
- Case Study 3: **Coated paperboard packaging** (Paperboard/Coating)
In this case the recycled material will be paperboard, and the proposed functional barrier is coating applied to this recycled paperboard in its internal layer (in contact with foodstuffs). In case of coatings, limited information is available about the functional barrier performance when positioned in the inner part of packaging, in direct contact with foodstuffs. So it is considered as a priority to evaluate their performance as functional barrier.

The relevant impact BANUS will provide to the recycling and transformer industries (**plastic & paper**), can be summarised as an effective cost and a significant virgin material reduction compared to the conventional manufacturing processes of those food packages, regarding the following aspects:

- ✓ Each structure must incorporate a percentage of recycled material in one of its layers, **substituting** between 15-30 % w/w of the **virgin material by recycled one**.
- ✓ The **final functionality** of the package should be guaranteed. The objective is that the modification of original properties will be less than 10 % (considering as relevant functional properties: tensile properties (in case of films and sheets), compression properties (in case of trays), and permeability (OTR and WVTR in all cases).
- ✓ All the final structures will **comply with legislative requirements** (Regulation 1935/2004[i]., Regulation 10/2011[ii] and Regulation 282/2008[iii]).
- ✓ The **cost of the final structures** will be at least a 10-15 % **lower than original structures**.

Although the project's development is aimed at specific food packages, the knowledge acquired will be able to be applied to other sectors such as **other food packaging applications** in trays / flexible multilayer multimaterial / coated paperboard packaging, and **other packaging applications** with similar requirements (children articles, cosmetics, etc.).

All the non-confidential information generated so far under the project can be found in BANUS website (**http://banus-project.eu)**, in the open area.

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1.2 Project context and objectives

Regulation 10/2011 on plastic food contact, together with Regulation 282/2008 on recycled plastic food contact, set the stage for the use of post-consumer recycled plastic in food packaging applications. Their use is only permitted in two cases: if the recycled plastics come from an authorized recycling process, or **if the recycled plastics are placed behind a functional barrier,** with some limitations widely described in Section 1.2. Moreover, there is currently no harmonised EU legislation on paper and board articles and materials for food contact applications beyond the general requirements laid out in Framework Regulation 1935/2004.

Even though legislation exists, **the reality** is that there are still **many limitations for the use of recycled plastic in food contact applications**, as **only authorized recyclers** are allowed to provide these materials. These limitations to get authorized recycled materials from neighbouring providers could result at worst in the use of non-authorized recycled plastic, with the consequent safety risks. Moreover European packaging industry, as well as recyclers (mainly SMEs), suffer tough competition from emerging countries, with the subsequent lost in markets and thus employment. Innovative and sustainable products as the ones proposed in **BANUS** will open new markets for these enterprises, helping to keep the work (and jobs) in Europe.

BANUS project aims to **develop new multilayer structures** for food packaging applications, in order **to evaluate their properties as functional barriers**, using conventional polymers to achieve new functionalities and **open new potential markets for the traditional recycling companies in Europe.**

Taking into account that the main objective of the project is to **guarantee the suitability of the developed functional barrier layers**, it is necessary to check that, regardless of the quality of the recycled material used in the process, the functional barrier is able to prevent any migration of contaminants to food. The great advantage of **BANUS approach is to ensure highly efficient functional barriers to guarantee food safety when using recycled materials (plastic and paper) even coming from non-authorized recycling processes** in food packaging structures.

The project will consider the **substitution of a percentage of virgin material by recycled material** (paper or plastic) in the selected structures (thermoformed trays, laminated multilayer flexible package and coated paperboard package) in order **to develop more environmental friendly food packaging structures**. As the main requirement of food packages is always to guarantee food safety for consumers, this substitution will be achieved after evaluating the functional barriers positioned between recycled layers and foodstuffs.

BANUS project main innovations are focused on three different case studies, based on different materials, processed by different technologies and used for different applications, described as follows:

Table 1. Case studies.

	Case Study 1: Semi-rigid multilayer plastic packaging	**Case Study 2**: Flexible multilayer multimaterial packaging	**Case Study 3**: Coated paperboard packaging
Current structure	Ext | **PP/EVOH/PP** | Int	Ext | **Paper/PET met/PE** | Int	Ext | **Paperboard/Coating** |Int
Current processing technology	Co-extrusion	Lamination	Coating
Recycled material used in BANUS	**Recycled PP**	**Recycled paper**	**Recycled paperboard**
End users Applications			

BANUS project implies a great deal of innovation in the field of functional barriers because it proposes technical advances in each one of the three proposed cases studies.

Detailed objectives: in order to achieve the main objective of the project, i.e. to develop **new multilayer packages with functional barrier properties for food contact applications,** in order to include **recycled materials** in their structures, several specific objectives were defined:

FIGURE 1. CONTAMINATED PP PELLETS (CS1)

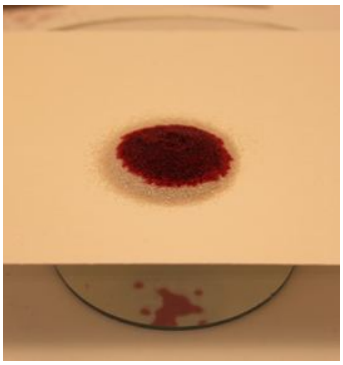

FIGURE 2. TESTING OF GREASE RESISTANCE BY TAPPI 454 TEST (CS3)

a) **Definition of potential functional barrier structures,** in order to comply with food contact legislation.
b) **Selection of the right contaminants:** to simulate the ones that could be present in recycled plastic and paperboard.
c) **Selection of the right contamination processes**, in order to contaminate virgin materials (PP, paper and paperboard) in an effective way.
d) The **selection of all the variables that can influence the contamination procedure** is a critical point in the project stages.
e) **Production of prototypes containing contaminated materials**. This stage is especially important in semi-rigid case study, in which contaminated material is incorporated to multilayer sheet by co-extrusion instead of lamination, because of high temperatures used in the transformation process.
f) **Selection of right migration tests conditions** in order to get final conclusions about functional barrier performance and above all, to guarantee food safety when using the tested structures in real packages. Selection of the most suitable technique for performing this verification is another task to develop.
g) **Verification of migration performance** for each case study. The measured migration of contaminants must be below 0.01 mg/kg, according to Regulation 10/2011.
h) To obtain at **industrial-level** the different structures using **recycled materials**, optimizing the production processes taking into account the peculiarities of the recycled materials compared to the virgin ones.
i) To check the **performance of the prototypes obtained at industrial-level** in terms of the requirements established.
j) To check the feasibility of the products developed both in terms of **environmental and economic impact** and of **regulatory and safety issues**.

The achievement of the above mentioned objectives will result in an increase of the competitiveness of the partners which represent the different types of companies involved in the supply chain of food contact packaging:

- *Transformers of plastics by extrusion or co-extrusion and lamination:* The development of new packaging structures by means of recycled plastic incorporation will represent an expansion of their market since these new structures maintain the desired properties for containing foodstuffs, but incorporating new advantages, not only from the environmental point of view, but also from costs approach. Moreover, the project can contribute to the consciousness of transformers about the importance of guaranteeing food safety when using recycled materials, by means of becoming familiar with the right ways of employing recycled materials for food contact applications.
- *Paper transformers* will have the knowledge about the performance of different coatings related not only to functional barrier performance, but also to other important properties. The study of different solutions for mineral oils controversy will promote recycled paper and paperboard keeping used for packaging in a safe way.
- *Plastic recyclers* will increase their volume of business since a new wide market will be opened to incorporate recycled materials for the new packages, whereas nowadays is mainly used for low-added value applications. For

plastic recyclers that are not in authorization process, this can be an opportunity, as packaging sector represents a great percentage of total plastic consumption.

- *Paper recycler expert* will have the knowledge regarding key aspects to make a safer use of recycled paper and paperboard in food contact applications. This fact has a special relevance in case of mineral oils controversy.
- *Food and agriculture Cluster* will acquire a direct knowledge about performance of several packaging structures related to food safety. This will result in a more reasoned selection of materials for packaging, including decisions about incorporating recycled materials in a safer way, being aware of real advantages and limitations.
- *Association of plastic companies* will acquire new knowledge on the materials and technologies related to **BANUS** and will find new opportunities and networking relations, and will exploit the Best Practices Guide for Training and Technology Transfer activities.

Expected final results and their potential impact and use:

Specific achievements of the project are:

- ✓ Development and optimization of the methods for evaluation of the functional barrier performance and the set-off effect in CS1, CS2 and CS3 structures:
  - Improved and validated contamination methodology, both at maximum levels of contamination and also at levels of contamination adapted to materials manufactured from common recycling processes.
  - Suitable transformation of the materials to obtain pilot-plant prototypes.
  - Knowledge on the characterization methods for different coatings.
  - Migration tests methods (devices adapted to achieve the correct exposure conditions of the samples, optimized chromatographic methods).
  - Increased knowledge about the performance of the contaminants inside the structures (migration, set-off, diffusion).
- ✓ Increased knowledge to manufacture the packages containing recycled materials at industrial scale:
  - Setting-up of the machinery, new devices/machine configurations to be used to have the suitable equipment for the correct multilayer barrier structures.
  - Processing parameters
  - Knowledge on the recycled materials to be used and potential modifications/improvements needed.
  - Knowledge on the performance of the coatings currently available in the market and potential modifications/improvements on the coating composition to achieve the expected performance in CS2 and CS3 packages.
- ✓ Increased knowledge on economic, environmental and safety aspects related to the use of recycled materials.

FIGURE 3. THERMOFORMED TRAY WITH RECYCLED PP AS CORE MATERIAL (CS1)

FIGURE 4. COATING / RECYCLED PAPER / METALLISED PET / PE COMPLEX PRODUCED (COATING SIDE) (CS2)

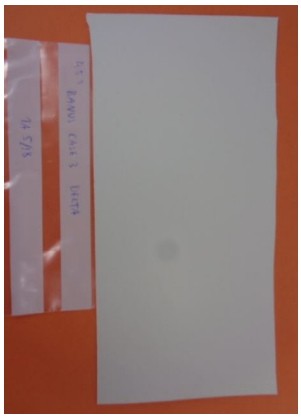

FIGURE 5. COATED PAPERBOARD(CS3)

Although final structures fulfilling all the requirements have not been achieved (due mainly to migration issues) at the end of the project, BANUS has finished providing relevant results that leave the partners in a better position to achieve the desired products in the near future.
Despite not reaching the overall project objectives, all the work developed has contributed to widen the SMEs technical knowledge portfolio that will be able to be used (at least partially) to boost their business.

In general terms, although after finishing BANUS, there are no commercial available results, it is a fact that there has been an advancement beyond the state-of-the-art, and it is partners´ objective to make use of it. The new knowledge acquired in the project can be transferred to the companies, so that they implement some improvements in their current processes and products, taking as a starting point the BANUS work.

After a recent update of the state-of-the-art (patents & technical articles) and market trends, it has been checked that the foreseen impact of the project as stated in Annex I, not only in terms of economic aspects, but also in terms of environmental and social benefits, is achievable although beyond the project duration. This overview of the trend in the packaging sector shows that, as foreseen since the proposal stage, the BANUS market goes on steadily growing over the years. If finally the searched global solution is found, for any of the Case studies included *(as per what it is described as 'further research necessary', in PUDF results analysis)*, the market impact for the corresponding recyclers and manufacturers (plastic, paper, board) is very ambitious.
That is why the BANUS consortium considers that is worthy continuing working on this research line, i.e. there is an actual demand from the market and clients´ side, and there is a potential market where the solutions should be implemented due to the foreseen increase and necessity of future sustainable solutions.

The work carried out in BANUS contributes to go further in the state-of-the-art, approaching the BANUS companies to a potential global solution. Thanks to BANUS, the consortium is aware of what there is in the market, which options can properly work and what remains now pending is to develop those potential customized solutions found out after the BANUS project, based on its acquired foreground.

1.3. Main scientific and technological results and foregrounds

The work in the project has been structured in eight work packages, arranged as shown in figure 5.

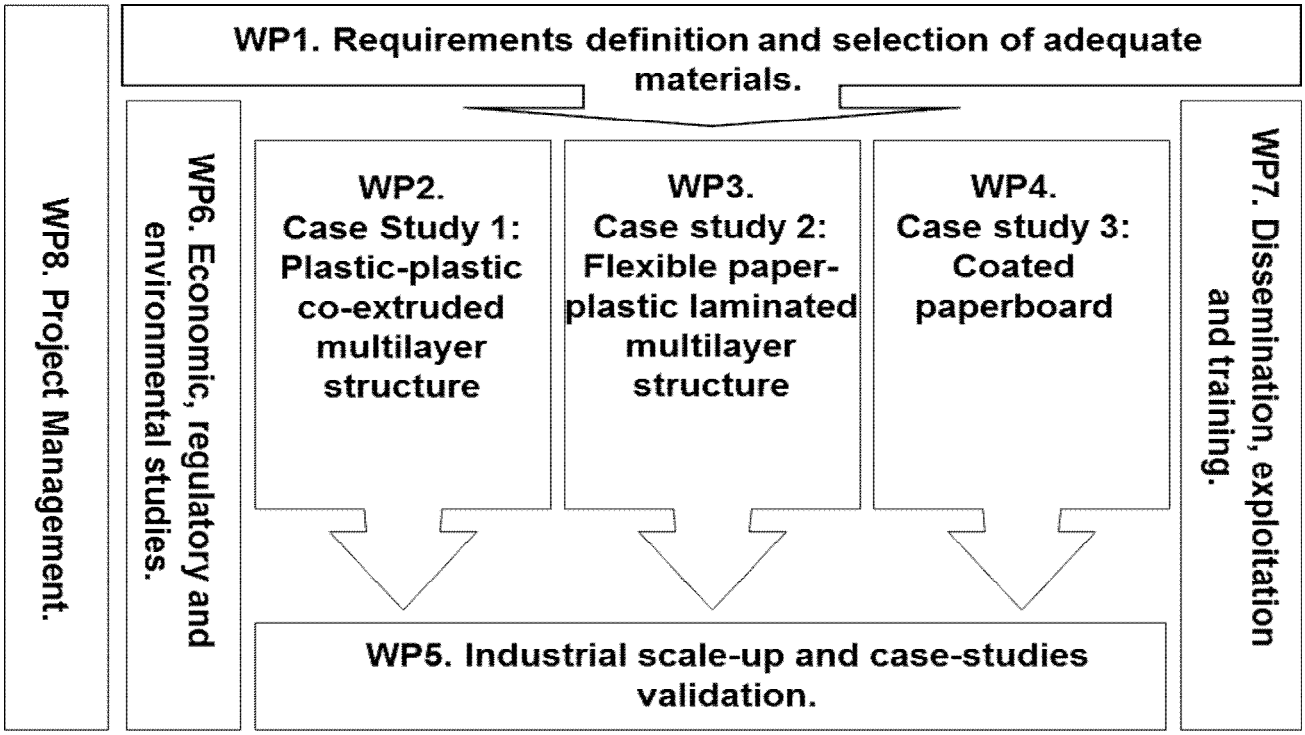

FIGURE. 5. GRAPHICAL PRESENTATION OF THE WP SHOWING THEIR INTERDEPENDENCIES (PERT DIAGRAM)

The main scientific and technological results achieved are the following, presented in a WP per WP basis.

PARTNERS´ LIST-for reference

Nº	Participant organization name	Short name	Type	Country
1	**AIMPLAS**	**AIMPLAS**	RTD	**ES**
2	INNVENTIA	INNVENTIA	RTD	SE
3	BOBINÓ	BOBINO	SME	FR
4	HELIOMUR	HELIO	SME	ES
5	MTM PLASTICS	MTM	SME	DE
6	DELTA	DELTA	SME	IE
7	BUMAGA B.V	BUMAGA	SME	NL
8	Fundación Clúster Agroalimentario de la Región de Murcia (AGROFOOD)-Terminated	AGROFOOD	OTHER	ES
9	Asociación Valenciana de Empresarios del Plástico (AVEP)	AVEP	OTHER	ES
10	Asociación empresarial de Investigación Centro Tecnológico Nacional de la Conserva	CTC	OTHER	ES

Below an explanation about the objectives, the work performed, end result obtained and degree to which the objective was reached can be found.
The details have been provided in the corresponding Task reports of those TECHNICAL WORK PACKAGES and their deliverables (confidential information sent only to EC):

WP1. Requirements definition & selection of adequate materials for packaging case studies and Risk MGT. D1.

WP2. Development of Case Study 1: Thermoformed package composed of a multilayer structure of PP/EVOH/PP. D2.1 and D2.2.

WP3. Development of Case study 2: Flexible laminated multilayer composed of Paper/PET met/PE. D3.1 and D3.2.

WP4. Development of Case study 3: Coated paperboard. D4.1 and D4.2.

WP5. Industrial scale-up and case-studies validation. D5.1, D5.2 and D5.3.

WP6. Economic, regulatory and environmental studies. D6.1, D6.2 and D6.3.

WP7. Dissemination, Exploitation and Training. D7.1, D7.2, D7.3, D7.4, D7.5 and D7.6.

Note that D7.1, D7.2, D7.3, D7.4, D7.5 and D7.6 belong to Dissemination, Exploitation and Training (WP7) and D8.1, belongs to the Project Management (WP8), not included in this description.

WP1. Requirements definition & selection of adequate materials for packaging case studies and Risk MGT.

OBJECTIVE	WORK PERFORMED	END RESULT	COMPLETION DEGREE (%)
Task 1.1 Selection of requirements for case studies structures. **Task 1.2 Selection of the proposed case study structures.** **Task 1.3 Risk Management** **Contractors involved** ▪ **AIMPLAS** ▪ **INNVENTIA** ▪ **BOBINO** ▪ **HELIO** ▪ **MTM** ▪ **DELTA** ▪ **BUMAGA** ▪ **AGROFOOD** ▪ **AVEP**	The definition of the main requirements for the final product for selected case studies and the selection of structures to be evaluated (raw materials, thicknesses of the different layers, final application) have been carried out during tasks 1.1 and 1.2 respectively as the starting point for the development of the project. To make this selection it has been taken into account: - The products currently marketed that are of interest for the partners. - The S&T objectives of the project: Each structure must incorporate a percentage of recycled material in one of its layers, substituting between 15-30 % w/w of the virgin material by recycled one. The final functionality of the package should be guaranteed. The objective is that the modification of relevant functional properties will be less than 10 %. The risk indicators have been identified in order to monitor their progress along the project duration. Some contingency plans have been already proposed in case any deviations occur during the project that jeopardise the achievement of the success indicators.	The starting point for the three case studies of the project has been established. The selected structures are based on products that are currently in the market. The only modification to be introduced initially in the project is the replacement of a percentage of virgin material with recycled material. Set-off phenomenon has been taken into account in the selection of the structures. Risks indicators have been assessed for each WP taking into account the technical and economical risks of the work performed and to be developed in each WP.	The objective was 100% successful, from the technical point of view.

CONCLUSIONS

The starting point for the three case studies of the project has been established as can be seen in Table 1.

TABLE 1. Summary of the structures selected and the corresponding requirements to be taken into account in the evaluation of the final products.

STARTING POINTS ESTABLISHED		CS1	CS2	CS3
		Thermoformed PP/EVOH/PP trays	**Flexible multilayer multimaterial packaging (Paper/PET met/PE)**	**Coated paperboard packaging**
REQUIREMENTS		Barrier properties. Mechanical properties: compression properties, impact resistance	Barrier properties. Mechanical properties: delamination strength, coefficient of friction (CoF), tear resistance.	Mechanical properties: flexibility (ability to be creased), resistance to abrasion.
FINAL APPLICATION	**Type of food in contact**	Fatty liver (foie gras)	Preparations for soups in powder form (extracts, concentrates)	1- Fast food (high fat content) 2- Cereals
	Time and temperature contact conditions	Sterilization (80°C for 60 minutes or 90°C for 115 minutes following references which approximates pasteurization) and subsequent long term storage at room temperature or below.	Long term storage at room temperature.	1- Short term storage of hot foodstuffs. 2- Long term storage at room temperature.
STRUCTURES TO BE EVALUATED		Virgin PP + Tie / Recycled PP + Tie / EVOH / Virgin PP + Tie Virgin PP + Tie / EVOH / Recycled PP + Tie / EVOH / Virgin PP + Tie	Virgin Paper / Tie / Recycled Paper / Tie / Metalized PET / Tie / PE (Finally discarded) Coating / Recycled Paper / Tie / Metalized PET / Tie / PE	Virgin Paperboard / Tie / Recycled Paperboard / Coating (Finally discarded) Coating / Recycled Paperboard / Coating (Selection of coating to be made under WP4)

WP2. Development of Case Study 1: Thermoformed package composed of a multilayer structure of PP/EVOH/PP.

OBJECTIVE	WORK PERFORMED	END RESULT	COMPLETION DEGREE (%).
Task 2.1 Selection of the contaminants to be used for the challenge test. **Task 2.2 Plastic contamination, for the manufacturing of the contaminated package layer (Polluted PP).** **Task 2.3 Pilot plant co-extrusion to obtain the multilayer structure (PP/Contaminated PP/EVOH/PP).** **Task 2.4 Migration study for multilayer structure PP/Contaminated PP/EVOH/PP.** **Task 2.5 Evaluation of results and optimization: functional barrier performance.**	The principal aim of WP2 is to evaluate the activity as functional barrier of EVOH/PP used in multilayer structures. For this purpose the following work has been performed: - Selection of the contaminants that will be used. - Selection of the conditions of the contamination process. - Execution of the contamination of virgin PP with the surrogate contaminants to ensure that the polymer matrix has embedded them. - Manufacture prototypes using contaminated PP by co-extrusion & thermoforming. - Selection of the migration test conditions. - Migration tests to evaluate the functional barrier performance.	Specific compounds have been selected to cover a wide range of contaminants in a worst-case scenario for the evaluation of the EVOH/PP barrier. Improved and validated contamination methodology has been developed. Suitable transformation of the materials to obtain pilot-plant prototypes has been performed. Migration tests methods have been optimized to perform a correct evaluation High levels of contaminants in the simulants after the exposure stage have been quantified that do not permit us to prove that any of the structures tested acts as functional barrier. New working lines have been defined: Reduction of the concentration of the contaminants & Study of the diffusion of contaminants during the co-extrusion process.	The objective was 100% successful from the method of evaluation of the functional barrier performance point of view. The additional work derived from the results obtained continued in WP5, task 5.1.
Contractors involved ▪ **AIMPLAS** ▪ **BOBINO** ▪ **MTM** ▪ **CTC**			

CONCLUSIONS

From the results obtained for the moment it cannot be proved that any of the structures tested acts as functional barrier. Table 2 shows the results obtained. Additional work in this sense will be performed under WP5. The structure initially selected for industrial trials was: Virgin PP + tie / EVOH / Recycled PP + tie / EVOH / Virgin PP + tie; 34.5% / 3% / 25% / 3% / 34.5%; Total thickness 1500 microns

Figure 6. Example of thermoformed tray tested.

TABLE 2. Migration results obtained employing Ethanol 95% as simulant.

Sample	Surrogate	Mean value (ppm)
PP/EVOH/PPcont(30%)/EVOH/PP PRO12-0149-01-09-05 (trays obtained with co-extrusion)	Benzophenone	24
	Phenylcyclohexane	*15*
	Toluene	*51*
	Chloroform	35
PP/EVOH/PPcont(40%)/EVOH/PP PRO12-0149-01-09-04 (trays obtained with co-extrusion)	Benzophenone	32
	Phenylcyclohexane	*20*
	Toluene	*62*
	Chloroform	37

WP3. Development of Case study 2: Flexible laminated multilayer composed of Paper/PET met/PE.

OBJECTIVE	WORK PERFORMED	END RESULT	COMPLETION DEGREE (%).
Task 3.1 Selection of the contaminants to be used for the challenge test. **Task 3.2 Preparation of contaminated paper samples (Contaminated paper).** **Task 3.3 Pilot plant lamination to obtain the multilayer structure (Paper/Contaminated Paper/PET met/PE).** **Task 3.4 Migration study for multilayer structure Paper/ Contaminated Paper/ PET met/PE.** **Task 3.5 Evaluation of results and optimization: functional barrier performance.**	The principal aim of WP3 is to evaluate the activity as functional barrier of PET met/PE used in multilayer structure. For this purpose the following work has been performed: - Selection of the contaminants that will be used. - Selection of the conditions of the contamination process (spiking). - Execution of the contamination of virgin paper with the surrogate contaminants. - Manufacture prototypes by lamination. - Selection of the migration test conditions. - Migration tests to evaluate the functional barrier performance.	Specific compounds have been selected to cover a wide range of contaminants in a worst-case scenario for the evaluation of the EVOH/PP barrier. Improved and validated contamination methodology has been developed. Suitable transformation of the materials to obtain pilot-plant prototypes has been performed. Migration tests methods have been optimized to perform a correct evaluation Exaggerated worst case conditions have been applied by means of 4 different spiking procedures performed. The results show that the PET met/PE is a functional barrier for the chosen contaminants in realistic conditions. Set-off phenomenon must be avoided by introducing an external coating in the structure. This coating will be selected according to WP4 results.	The objective was 100% successful.
Contractors involved ▪ **AIMPLAS** ▪ **INNVENTIA** ▪ **HELIO** ▪ **BUMAGA** ▪ **CTC**			

CONCLUSIONS

From the results obtained for the moment is concluded that PET met/PE is a functional barrier for the chosen contaminants in realistic conditions. Table 3 shows the results obtained. The structure to be scaled-up was: Coating / Recycled Paper / tie / metallised PET / tie / PE; coating will be selected according to WP4 results.

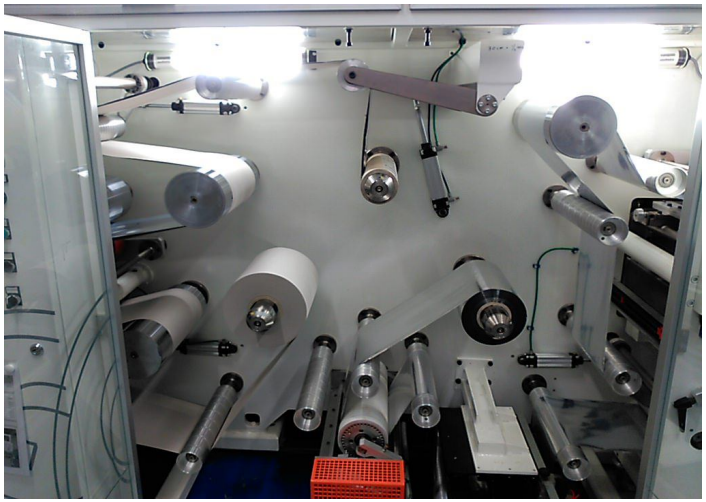

Figure 7. Pilot plant lamination set-up.

TABLE 3. Migration results.

Sample	Contaminant	Result (ppm)
Spike 1 + Virgin Paper/ met PET/PE	Aniline	<0.01
	Acethophenone	0.02
	2-methyl-4-isothiazoline-3-one	<0.01
	Naphthalene	0.05
	Vanillin	<0.01
	1,2,3-Trichloroanisole	0.03
	TXIB	0.02
	Benzophenone	<0.01
	DIPN	0.11
	Butylphthalate, DBP	<0.01
	Anthraquione	<0.01
	Bisphenol A	<0.01
	Tetracosane	<0.01
	Diethylhexyl phthalate, DEHP	<0.01
Spike 2 (dirty paper)/ met PET/PE	Mineral oils (MOSH and MOAH)	<0.01
	Dehydroabietic acid	<0.01
	Unknown compounds	0.33
	Alkanes	0.17
Spike 3 + Virgin Paper/ met PET/PE	Mineral oils (MOSH and MOAH)	<0.01
Spike 4 + Virgin Paper/ met PET/PE	Boric acid (B)	0.01
	Tributyltin oxide	<0.05

WP4. Development of Case study 3: Coated paperboard.

OBJECTIVE	WORK PERFORMED	END RESULT	COMPLETION DEGREE (%).
Task 4.1 Selection of the contaminants to be used for the challenge test. **Task 4.2 Preparation of contaminated paperboard samples (Contaminated paperboard).** **Task 4.3 Lab coating of paper boards to verify the coating (Paperboard/Contaminated Paperboard/functional barrier coating).** **Task 4.4 Migration study for multilayer structure Paperboard/ Contaminated paperboard/Coating.** **Task 4.5 Evaluation of results and optimization: functional barrier performance.** **Task 4.6 Evaluation of properties crytical for full scale application**	The principal aim of WP4 is to evaluate the activity of several types of coatings as functional barrier for paperboard. For this purpose the following work has been performed: - Selection of the contaminants that will be used. - Selection of the conditions of the contamination process (spiking). - Execution of the contamination of virgin paperboard with the surrogate contaminants. - Manufacture prototypes by coating application. - Selection of the migration test conditions. - Migration tests to evaluate the functional barrier performance.	Specific compounds have been selected to cover a wide range of contaminants in a worst-case scenario for the evaluation of the functional barrier performance. Different coating procedures have been evaluated. A selective screening has been performed in a laboratory set up to identify candidate coatings: The screening criteria to guide the selection of candidate coatings has been the high penetration resistance to fats and oils (>1800s) according to TAPPI 454 test. A total of 19 coatings have been subjected for verification for migration test. In the screening of the dry coat weight determination and the Tappi 454 test about 120 applications of potential candidate barrier coating have been made. From the screening test 8 double and 1 single candidate barrier coating have been approved for migration test. For these 8 double and 1 single candidate barrier coating a more precise dry coat weight has been determined. Coating “C” has found to be functional barrier for mineral oils based.	The objective was 100% successful.
Contractors involved ▪ **INNVENTIA** ▪ **DELTA** ▪ **BUMAGA** ▪ **CTC**			

CONCLUSIONS

From the results obtained for the moment is concluded that Coating “C” has found to be functional barrier for mineral oils based. Table 5 shows the results obtained for this coating. The structure to be scaled-up was: Recycled Paperboard / Coating C.

TABLE 4. Lab coating procedure for tested coatings

Coating	Board	Coating procedure steps					
		1st				2nd	3rd
		Coat weight screening		Tappi 454 test		Dry coat weight for candidate barrier coating	Candidate barrier coating for migration test
		Square area	Circular area	Double coating	Single coating		
A	SE	X		X	X		
B	SE	X		X	X		
C	SE	X		X	X	X	X
D	SE	X		X	X	X	X
E	SE	X		X	X		
F	SE	X		X	X		
G	SE	X		X	X		
H	SE		X	X	X		
I	SE		X	X	X		
J	SE		X	X	X		
K	SE		X	X	X	X	X
L	SE		X	X	X	X	X
L (single)			X	X	X	X	X
M	SE		X	X	X	X	X
N	SE		X	X	X	X	X
O	SE			X	X		
P	SE		X	X	X	X	X
Q	SE		X	X	X	X	X
R	SE		X	X	X		
S	SE		X	X	X	X	X

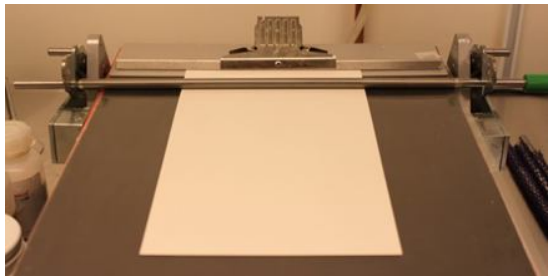

Figure 8. Laboratory auto drawdown coater

TABLE 5. Migration results of selected Coating C.

Sample	Contaminant	Result 2h 70ºC (ppm)	Result 10d 60ºC (ppm)
Spike 1 + Coating C **(28 g/m²)**	Aniline	0.03	<0.01
	Acethophenone	0.02	0.01
	2-methyl-4-isothiazoline-3-one	<0.01	<0.01
	Naphthalene	0.12	0.12
	Vanillin	<0.01	<0.01
	1,2,3-Trichloroanisole	<0.01	0.03
	TXIB	0.01	0.69
	Benzophenone	<0.01	<0.01
	DIPN	<0.01	0.15
	Butylphthalate, DBP	<0.01	<0.01
	Anthraquione, AQ	<0.01	<0.01
	Bisphenol A	<0.01	<0.01
	Tetracosane	<0.01	<0.01
	Diethylhexyl phthalate, DEHP	<0.01	<0.01
Spike 2 (dirty paper)/ Coating C **(28 g/m²)**	Sum of migration	<0.01	0.5
Spike 3 + Coating C **(28 g/m²)**	Mineral oils (MOSH and MOAH)	<0.01	<0.01
Spike 4 + Coating C **(28 g/m²)**	Boric acid (B)	*	*
	Tributyltin oxide	*	*
	* The coating was dissolved in the migration simulant 3% acetic acid and the migration test results are not reported.		

WP5. Industrial scale-up and case-studies validation

OBJECTIVE	WORK PERFORMED	END RESULT	COMPLETION DEGREE (%).
Task 5.1 Case study 1: Co-extrusion of PP/recycled PP/EVOH/PP at industrial level. **Task 5.2 Case Study 2: Lamination of Paper/Recycled paper/PET met/PE at industrial level.** **Task 5.3 Case Study 3: Coating of recycled paperboard.** **Task 5.4 Kinetics of migration for final case studies.** **Task 5.5 Final industrial validation.** **Contractors involved** ▪ **AIMPLAS** ▪ **INNVENTIA** ▪ **BOBINO** ▪ **HELIO** ▪ **MTM** ▪ **DELTA** ▪ **BUMAGA** ▪ **AGROFOOD** ▪ **AVEP**	The main objectives of WP5 are: To obtain at industrial level the different structures developed at lab-scale level in the previous work packages, using real recycled materials. To complete the work to ensure the compliance of the final structures with the requirements of the Food Contact Materials' legislation. To check the differences between current marketed structures and prototypes obtained, taking into account the properties selected in WP1.	CS1: - Processing: Increased knowledge and valid prototypes achieved but further optimization would be needed. - Migration: Results obtained do not permit us to prove that any of the new structures tested acts as functional barrier either. Further trials and optimizations designated to achieve the functional barrier performance are needed beyond the end of the project (diffussion studies, modifying of processing tecnology). - Functionality: there is no significant variation in the yield point (the most important parameter in the thermoforming process) when comparing the structures with virgin and recycled material; On the other hand it can be seen that compression has fallen about 25% (although the values are still appropiated for their work). CS2: - Processing: Increased knowledge and valid prototypes achieved but further optimization of the coating would be needed. - Migration: Results show that the final product (PE/metPET/partly recycled paper/coating) almost can be considered as a functional barrier package but further trials and optimizations designated to avoid set-off would be needed for full implementation. - Functionality: The adhesion tests show that the PET/PE adhesion is excellent for both the pilot coated sample and the reference sample; Other mechanical properties, such as tearing test and adhesion showed good overall values for both the reference sample and the pilot coated sample.	The objective was 80% successful, due to the fact that, although there has been a considerable advancement beyond the state-of-the-art, approaching the BANUS companies to a potential global solution, at the end of the project additional optimizations are needed in the 3 CS to obtain structures fulfilling all the requirements.

		CS3: - Processing: Increased knowledge and valid prototypes achieved. - Migration: The industrial scale produced samples showed poorer migration results than the samples produced in lab environment in WP 4. They showed properties as a barrier against migration of mineral oils from a secondary package of recycled fibre but they are not yet in compliance with the definition of a functional barrier. - Functionality: The barrier properties (OTR, WVTR) as well as the mechanical properties were not within the requirements. A further development of the coating is required to make it persists e.g. creasing and without cracking.	

CONCLUSIONS

Although at the end of the project additional optimizations are needed in the 3 CS to obtain structures fulfilling all the requirements, thanks to BANUS, the consortium is aware of what there is in the market, which options can properly work and what remains now pending is to develop those potential customized solutions found out after the BANUS project, based on its acquired foreground.

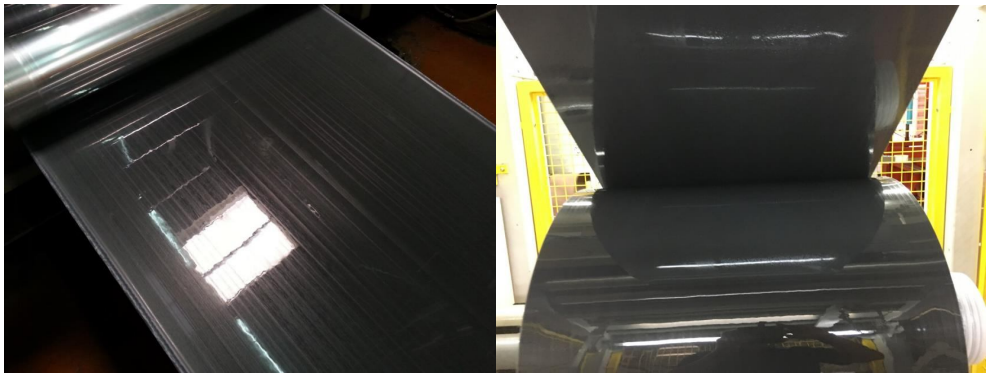

Figure 9. Multilayer film co-extrusion with Recycled PP as core material (CS1).

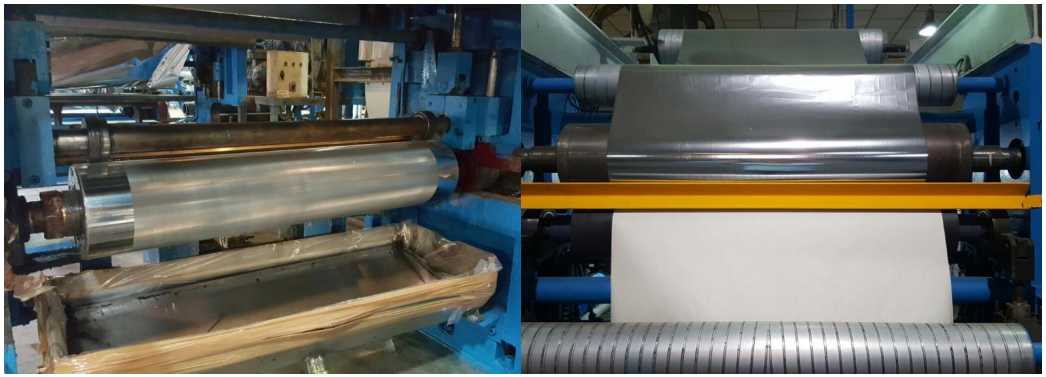

Figure 10. Left: Gravure roll used for solvent based lamination. Right: Recycled paper / PETmet lamination (CS2).

Figure 11. Left: Optimization of the coating viscosity. Right: Anilox coating rollers (CS3).

WP6. Economic, regulatory and environmental studies

OBJECTIVE	WORK PERFORMED	END RESULT	COMPLETION DEGREE (%).
Task 6.1 Economic and regulatory studies. **Task 6.2 Product Life-Cycle-Analysis (LCA).** **Task 6.3 Safety Issues.** **Contractors involved** ▪ **AIMPLAS** ▪ **INNVENTIA** ▪ **BOBINO** ▪ **HELIO** ▪ **MTM** ▪ **DELTA** ▪ **BUMAGA** ▪ **AGROFOOD** ▪ **AVEP**	WP6 was focused on achieving the following objectives: - Deep economic study to evaluate the economic viability of the developed products (LCC). - Environmental analysis to study the environmental impact of the new package structures containing recycled materials in comparison with the current structures based on virgin materials (LCA). - Updated regulatory analysis at EU level. - Complete safety evaluation for each application.	The BANUS project objective to incorporate a percentage of recycled material in one of the packaging structure layers, by substituting between 15-30 % w/w of the virgin material by recycled one, has been achieved. Environmental impact and total costs of the packaging structures per Case Study are summarised in Table 6. The LCA study demonstrated that the environmental impacts of the new packaging structures are lower than of the current packaging structures in all three cases due to the substitution of virgin material with recycled material. The current LCC study focused on the material and energy costs. The difference in economic results for the current and the new structures was in the range of - 0,9% and 6 %. Regarding regulatory requirements and safety issues, an analysis of the legislation and related regulations was made. Information related to safety data sheets of the materials used in the case studies was collected to serve as a basis for the safety study.	The objective was 100% successful in all tasks, except for the economic study, since the economical objective of this WP (namely, the cost of the final structures will be at least a 10% lower than original structures) was not reached. The partial achievements of the economic objective are, however, balanced with the environmental advantages in all Case Studies.
Once the optimal performance of the functional barrier coating can be achieved and the new packaging structures are also optimized, it can be then recommended that the SMEs follow up the economic and environmental impact of the improved packaging structures. This will allow capturing further potential improvements in the environmental impact of all packaging structures and fulfilling of the BANUS project economic objectives.			

TABLE 6 Overview of the decrease/increase of carbon footprint/life cycle costs for all three cases.

	Difference between the current and the new case.	
	Life cycle costs [€/kg or €/m^2]	**Carbon Footprint** [CO^2-eq/kg or CO2 – eq/m^2]
Case study 1 (Screening study)	-0,9%	-12 %
Case Study 2 (Screening study)	-8%	-7 %
Case Study 3 (A detailed study)	+6%	-27%

1.4 Potential impact and main dissemination activities and exploitation of results

Dissemination Activities

It is essential to highlight that a considerable number of dissemination activities have been completed during the development of the BANUS project, i.e. More than 50 communications made, almost 30 dissemination activities in different events (fairs, conferences, workshops, info-days, exhibitions), Project video available, in the front page of the project website, Project end workshop-May 2016).All the details are given in the PDF submitted attached report-RP2. Moreover, there are 1 final press release, 2 fairs and 3 conferences/seminars which are planned to be carried out before the end of 2016. The project information has been disseminated via three channels:

a) By partners, within their organizations and with their clients/contacts (e.g. companies newsletters, meetings, seminars, training courses, etc.)
b) By partners, during external events (e.g. fairs, conferences, networking events, workshops, etc.)
c) By partners, using media across Europe (e.g. press release, Internet, specialized/sectorial magazines, etc.)

The use of various channels and methods (written, face-to-face & online) assured an optimal contribution of coverage, visibility and most important- setting up the scene for better market acceptance in the near future.

The activities in the Dissemination Plan covers different audiences and channels depending on the type of information to be disseminated, in order to assure the success of the project from a strategic, environmental, technologic and economic direction based on BANUS approach.

Dissemination tools and activities could be divided in two main groups:

a) *Industrial level*: For the SMEs, the principal objectives are to obtain results that will increase their competitiveness and market opportunities and to show these results to any potential client, in order to have a wider commercial activity and increase the company benefits. Activities such as participation in fairs, seminars, press releases…are aiming these results.
b) *Non-commercial level:* The RTD participants of the project are more focussed in non-commercial promotion and scientific aspects of the work. Only non-confidential project results are susceptible of publication or dissemination in journals, web-sites, congresses, workshops, fairs and seminars.

Therefore, it is clear that the dissemination actions for the BANUS project is continuing after the end of the project, focused on both the commercial and scientific audience, aiming at the continuation of the work, to work on a possible future exploitation of the project knowledge in some way. Different Dissemination tools have been prepared, such as:

-Maintenance of the Online portal – Website: **http://banus-project.eu**

-BANUS Logo

-Leaflet

-General presentation of the project

-Press releases

-Videoclip of the project results

-“Guide to design and manufacture multilayer multimaterial packages containing recycled materials, with functional barrier properties, for food packaging applications”

All these resources are available at the Public part of the website and will be displayed in fairs and meetings.

Potential Impact and Exploitation

The new multilayer structures for food packaging applications developed in the BANUS project, may have a significant impact in the **food packaging industry** providing environmentally friendly alternatives to the current packages, made of virgin polymers.

In general terms, although after finishing BANUS, there are no commercial available results, it is a fact that there has been an advancement beyond the state-of-the-art, and it is partners´ objective to make use of it. The new knowledge acquired in the project can be transferred to the companies, so that they implement some improvements in their current processes and products, taking as a starting point the BANUS work.

Therefore, once **their properties are totally guarantee as functional barriers**, those new packaging using conventional polymers, will **open new potential markets for the traditional recycling companies in Europe.**

True industrial impact will require further investment, mainly aimed to optimize the actual 3 structures at scale-up level, making them suitable for fulfilling the current legislation, and also profitable for the SMEs involved in the production chain.

Although the project's development is aimed at specific food packaging (according to the end-user business field and what was agreed under Annex I of the project), the structures developed (protected by an Exploitation Agreement under signature process among the whole consortium) will be able to be applied to other type of packaging sectors (such as other food packaging applications in trays, or other packaging applications with similar requirements (children articles, cosmetics, etc.), provided that the specific requirements of each final product can be fulfilled/adjusted from the starting characteristics of the new structure developed.

All the abovementioned sectors could be additional business for the SMEs involved in the value chain (recyclers, plastic manufacturers, end-users/distributors). The owners of the different results defined in the final version of the Exploitation Agreement will take into account these new niche market sectors.

Therefore, the protection plan of the project results is already initiated with the request for the official signature of the BANUS Exploitation Agreement-final version.

Finally, it is important to highlight that the BANUS partners keep as an option the possibility to go on working together in this field (with related developments). For example, MTM & BOBiINO showed their interest in collaborating together in the potential new uses of their recycled PP, out of the food packaging scope of BANUS, with AIMPLAS´ support if necessary. DELTA, BUMAGA and INNVENTIA will also may collaborate in the future to improve what now has been identified in the coatings field.

1.5 Website and contact details

The BANUS website, **http://banus-project.eu,** was established at the beginning of the project. Deliverable 7.4 "Project website" gives an overview of the main functionalities and structure of the website. The intended audience is double: the public at large (industry stakeholders, academia, EU and national officials, etc.) and/or the beneficiaries involved in the project, the consortium.

Technical, economic and social objectives, the expected results, and non-confidential intermediate were included. This area included a Technology Watch Service provided by AIMPLAS using the proprietary software SoftVT, which provided an update of the available patents, market information, publications, etc, issued in relation to the BANUS activities and that might be of interest for the BANUS project. After the end of BANUS the web-site will be used as a useful dissemination tool for the project results.

Contact details:
AIMPLAS (Coordinator)
Tlf. +34 96 136 60 40
Fax +34 96 136 60 41
proyectos@aimplas.es

2. Use and dissemination of foreground

This document presents the plan for using and dissemination of the foreground for BANUS project. The plan focuses on both Dissemination and Exploitation activities.
The Dissemination plan **(section 2.1., A. PUBLIC)** includes a description of what is understood by dissemination in this context, the objectives of dissemination and the structure (activities and tools/materials).
The Exploitation strategy and activities **(section 2.1, B. CONFIDENTIAL)** gives an overview on how partners have agreed to carry out the exploitation of the project results, according to the Consortium Agreement signed by all partners and the subsequent Exploitation commitment agreed among all industrial partners (SMEs).
However, all the details on such Exploitation strategy were included in the PUDF-final version (Deliverable 7.2)

SECTION A. Dissemination Measures. *PUBLIC*

In this context dissemination should be understood as a collection of activities and tasks promulgated at various levels and targeting various stakeholders, aiming wide diffusion of the research results generated by the project consortium.

The aims of this section are to describe the target audience, key dissemination tools used during the project lifetime and their execution timeframe.

2.1.1. Scope of the Dissemination – Main lines considered

The activities in the Dissemination Plan covers different audiences and channels depending on the type of information to be disseminated, in order to assure the success of the project from a strategic, environmental, technologic and economic direction based on BANUS approach.

Dissemination tools and activities could be divided in two main groups:

c) *Industrial level*: For the SMEs, the principal objectives are to obtain results that will increase their competitiveness and market opportunities and to show these results to any potential client, in order to have a wider commercial activity and increase the company benefits. Activities such as participation in fairs, seminars, press releases…are aiming these results.
d) *Non-commercial level:* The RTD participants of the project are more focussed in non-commercial promotion and scientific aspects of the work. Only non-confidential project results are susceptible of publication or dissemination in journals, web-sites, congresses, workshops, fairs and seminars.

The dissemination actions for BANUS project will continue after the end of the project, looking for opportunities to further extent the knowledge acquired so far, and make possible its implementation in some way. Some scheduled examples so far can be found below:

-FORESEEN by AIMPLAS: Final Project press release, Resource Recycling Update magazine (Nov2016).

-FORESEEN by AVEP: Emballage Fair (November 2016) & K-FAIR October 2016

-FORESEEN by AIMPLAS: BANUS final results dissemination Multilayer Packaging Films 2016 (Nov2016), XI Foro del Embalaje Flexible, Barcelona (Sept2016) & Flexible Packaging Europe (FPE) Technical Committee, Viena (Oct2016)

2.1.2. Structure of the plan – dissemination tools and activities

I. Dissemination tools

Several dissemination tools were designed and used during the BANUS project lifetime. The main aim of such actions was to raise awareness about project's objectives & main innovations, to develop an identity for the project.

a. Online portal – Website

The BANUS website **http://banus-project.eu**
See some screenshots from the public part represented in figure 2.1.2a.
It is an important tool for the project's development and dissemination purposes. Since the beginning of the project, a website was designed and several functionalities have been added following the needs of the partners in the consortium. The online portal is structured in two parts: an *internal part or intranet* accessible only to and by the partners in the consortium, and an *online or public section* accessible to any stakeholder interested in project's developments and achievements.

The web site´s main aim is to create a communication gateway in two senses: outside the consortium with a marketing and publicity purpose, and inside the project consortium members with an active internal communication and optimal management purpose.

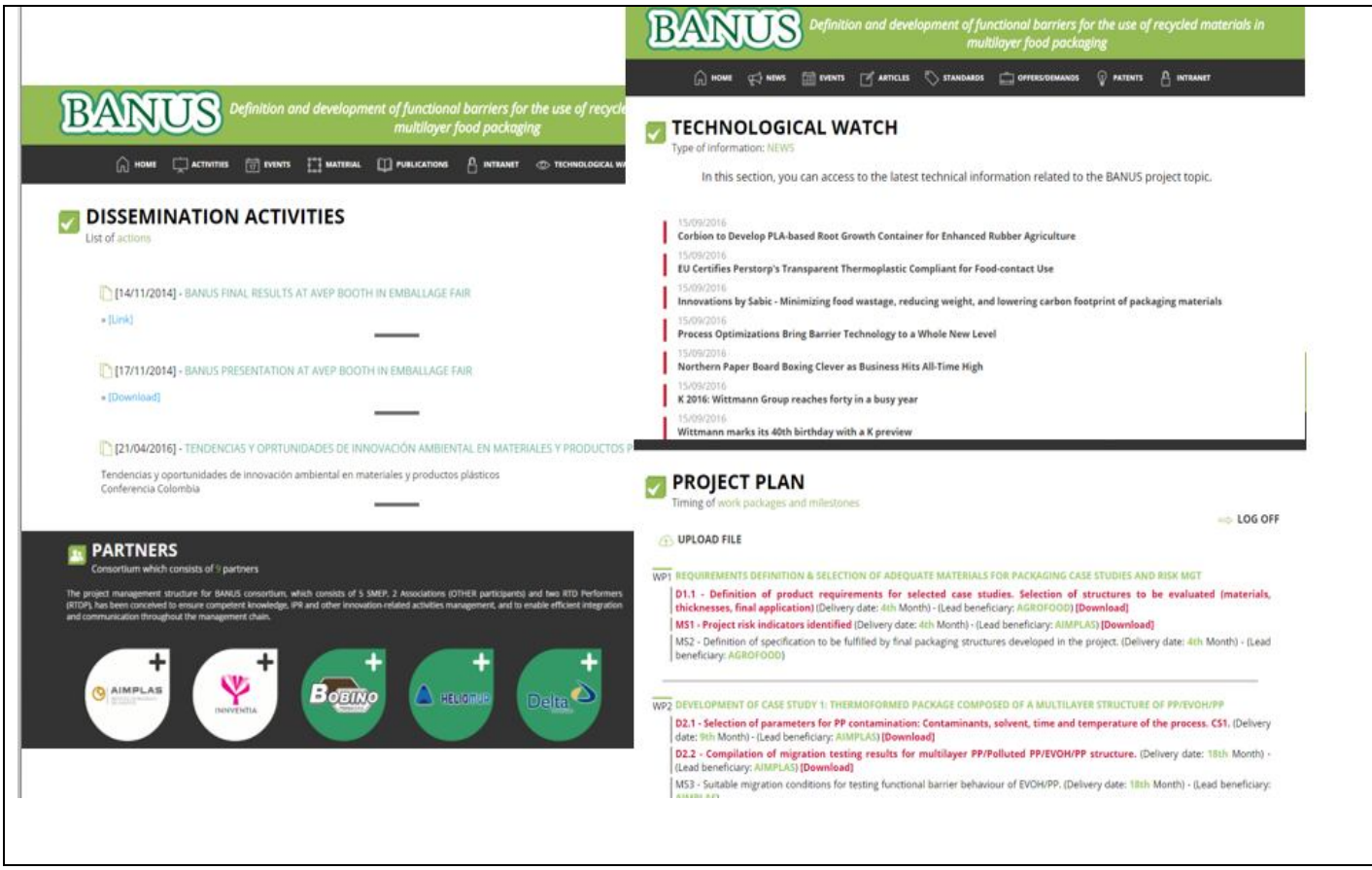

Figure 2.1.2a. **Different views of the Project website**

b. Project identity – BANUS Logo

The project's corporate identity allows BANUS to project an instantly recognisable visual image. The Project's logo is extracted from the project's name. The use of logo, represented in figure 2.1.2b., has been coherent in all publications and dissemination materials within the project. Also, the logo has been used by all partners in the written communications – templates, press releases, several project documents (minutes, agendas, official emails,...).

It is imperative for the project definition and identification purposes that no variations in terms of tones or fonts are to be used. Additionally, the use of logo by any other external party and for any purposes needs careful examination by the project's consortium.

BANUS

Figure 2.1.2b. **Project logo**

c. Leaflet

The project's leaflet, presented in figure 2.1.2c, has been an essential dissemination tool because of its extended use – online or paper based. Within the project, an initial leaflet was designed with the following objectives: 1) introduction of the project's consortium, 2) expected objectives and innovations during the project. The leaflet has been used during the various external and internal events where partners participated. The leaflet was updated with new pictures of the latest results, according t the project progress.

***Figure 2.1.2c*. Leaflet for the dissemination of BANUS.**

d. Presentation of the project

Since the beginning of BANUS activities, the content for a general presentation was drafted and used by partners in the project, according to their convenience by adapting the non-confidential content to their specific dissemination interests. The aim of such type of presentations was to introduce the external audience to the project. In general the usual common contents were: its beneficiaries, funding scheme, objectives, innovations, applications and potential access for further information. The general & non-confidential presentation was used as the main tool during international events, having therefore access to a high exposure and visibility. Figure 2.1.2d shows an example of several slides used in the general presentations of the project.

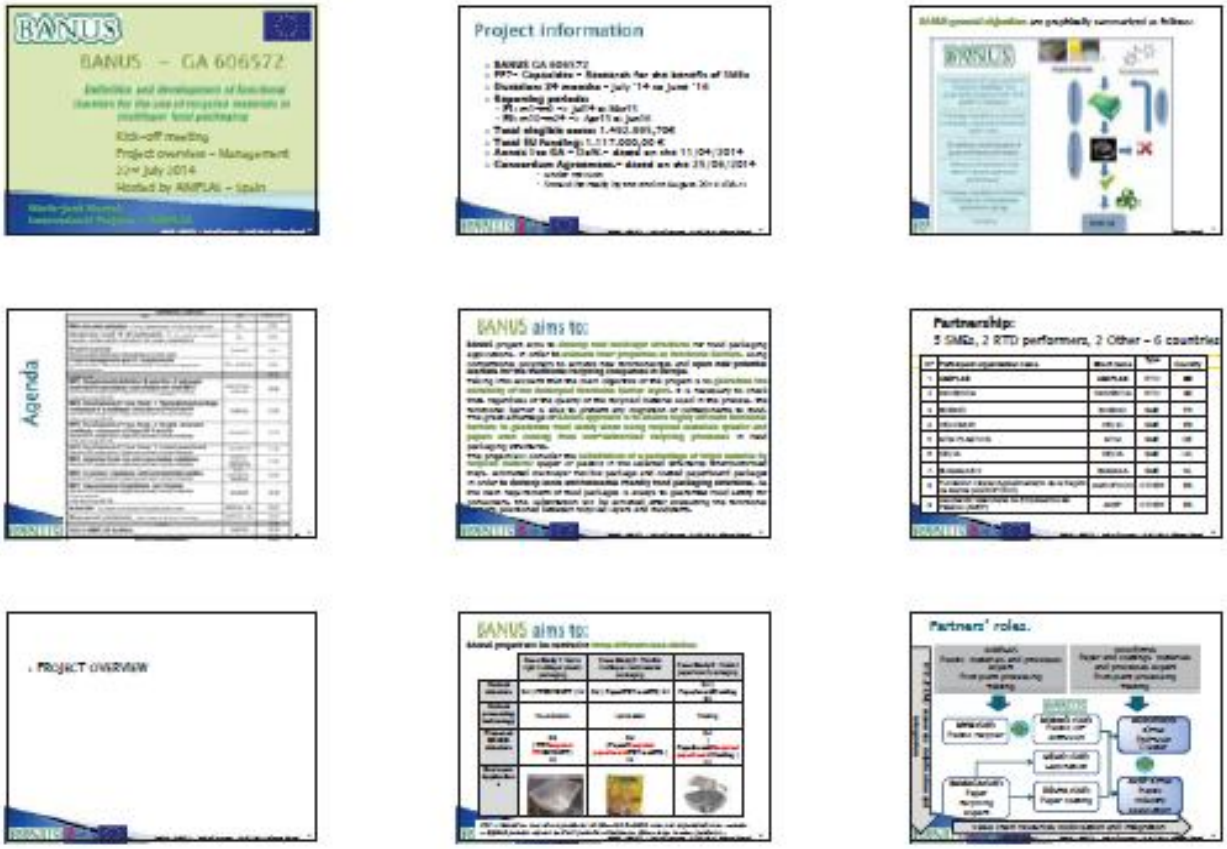

Figure 2.1.2d. Slides used in the general presentation for the dissemination of BANUS.

(a) e. Press release

As a very early stage activity, a press release with general content of the project was prepared and published in several mass media, as indicated in the dissemination activities table (Table 1 of this section 2).
The press releases were published both in hard and electronic media (newspapers/magazines, websites).

NOTICIAS AVEP NOTICIAS DEL SECTOR

BANUS - ENVASES MULTICAPA

Envases multicapa a partir de material reciclado en okPLAST: resultados de BANUS

BANUS

I Foro de Plásticos y Legislación

okPLAST 2016

20/10/2014 Packaging Europe News - Functional Barriers in Multilayer Food Pack

European packaging news, analysis, discussion and contacts

Functional Barriers in Multilayer Food Packaging

Released: 20/10/2014 11:11:00 Read 57 times

BANUS, a Research for SMEs project funded under the 7th Framework Programme, started last 1st of Jul developing new multilayer structures for food packaging applications.

The objective is to guarantee the suitability of the functional barrier layers regardless of the quality of the recycled mat The great advantage of BANUS approach is to ensure highly efficient functional barriers in order to guarantee food saf materials (plastic and paper) even coming from non-authorized recycling processes in food packaging structures.

The substitution of a percentage of virgin material by recycled material in the selected structures will be considered, in environmentally friendly food packaging structures.

As the main requirement of food packages is always to guarantee food safety for consumers, this substitution will be a functional barriers positioned between recycled layers and foodstuffs.

BANUS, with a planned duration of 24 months and a budget of 1.1M€, is composed of nine participants from six differe Sweden, BOBINO PLASTIQUE from France, MTM PLASTICS from Germany, DELTA PRINT & PACKAGING Ltd from Netherlands and HELIOMUR SCOOP, FUNDACION CLUSTER AGROALIMENTARIO DE LA REGION DE MURCIA, AS EMPRESARIOS DE PLASTICOS (AVEP) and AIMPLAS from Spain, this last as the project coordinator.

More info:
www.aimplas.es

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EU project to develop new food packaging barriers

By Amanda McCormack
Posted 22 October 2014

Aimplas, the Technological Institute of Plastics located in Valencia, Spain, has highlighted its involvement in Banus, a research project which has the primary objective of ensuring the safety of functional barriers in food packaging, regardless of the quality of the recycled material.

The Banus project, which is funded under the EU's 7th Framework Programme, began last July with a planned duration of 24 months and a budget of €1.1m. The project is composed of nine organisations, including Aimplas, from six different countries.

The Banus project was established to ensure highly efficient barriers for food packaging and to maintain food safety when using recycled materials, both plastic and paper, even when the materials come from non-authorised recycling processes for food packaging.

An Aimplas spokeswoman told *EPN*: "Aimplas, as a plastic materials and processes expert, is involved in Banus for the migration studies at laboratory scale, sheet co-extrusion, thermoforming and lamination at pilot plan scale. In addition, Aimplas is the Banus project coordinator".

"With Banus' development, Aimplas looks for increasing the technological knowledge about technologies and materials to develop multilayer packages with barrier properties for food contact applications, in order to include recycled material in their structures. This will then [help] to increase EU industry competitiveness," she continued.

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- Sales climbing for Wittmann Battenfeld 23 October 2014

Figure 2.1.2e. Example of press releases published for the dissemination of BANUS.

II. Dissemination activities

It is essential to highlight that several dissemination activities were activated and completed during the development of BANUS. The project information was disseminated via three channels:

d) By partners, within their organizations (e.g. internal newsletters, meetings, seminars, training courses, etc.)
e) By partners, during external events (e.g. fairs, conferences, networking events, workshops, etc.)
f) By partners, using media across Europe (e.g. press release, Internet, specialized magazines, etc.)

The use of various channels and methods (written, face-to-face & online) assured an optimal contribution of coverage, visibility and most important- setting up the scene for better market acceptance in the near future.

Table 1 of this section 2 summarises the dissemination activities (publications, conferences, workshops, web, press releases, brochures, etc) held by project partners during the whole BANUS project duration.

Table 1. **List of dissemination activities carried out by BANUS partners**

NO.	Details of the activity	Place	Date
	Press Releases, Media briefings, Websites		
1	AIMPLAS coordina el proyecto europeo BANUS (in Spanish)	IDE and IDE - NewsLetter	14/11/2014
2	AIMPLAS's BANUS Research Aims to Develop Functional Barriers for Multilayer Food Packaging	Special Chem , Special Chem - NewsLetter	12-13/11/2014
3	AIMPLAS DESARROLLA BARRERAS FUNCIONALES PARA EL USO DE MATERIALES RECICLADOS EN ENVASES MULTICAPA PARA ALIMENTACIÓN (in Spanish)	Plásticos y Caucho	03/11/2014
4	2014-10-30-Tecnología del Plástico-PRO13-0173-BANUS2-MARKETING (in Spanish)	Notiplastic Boletin	31/10/2014
5	Desarrollan proyecto para usar material reciclado en la fabricación de envases para alimentos (in Spanish)	Tecnología del Plástico	30/10/2014
6	Development of recycled materials in multilayer food packaging	Packaging Today	28/10/2014
7	AIMPLAS desarrolla barreras funcionales para el uso de materiales reciclados en envases multicapa para alimentación (in Spanish)	ENVAPACK – NewsLetter, , Izaro Manufacturing Technology, ENVAPACK – NewsLetter, Izaro Manufacturing Technology -NewsLetter	28/10/2014
8	Investigan el uso de mate riales reciclados en envases multicapa para alimentación (in Spanish)	TECNOALIMEN - NewsLetter	28/10/2014
9	Development of recycled materials in multilayer food packaging	Packaging Today	28/10/2014
10	Investigan el uso de mate riales reciclados en envases multicapa para alimentación (in Spanish)	TECNOALIMEN - NewsLetter	28/10/2014
11	TETRAPAK Lanza El Primer Envase Totalmente Hecho a Partir de Materiales Renovables Bio-Basados (in Spanish)	ENVAPACK	27/10/2014
12	Aimplas desarolla barreras funcionales para el uso de materiales reciclados en envases multicapa para alimentación (in Spanish)	Interempresas – NewsLetter; Izaro Manufacturing Technology ; Izaro Manufacturing Technology – NewsLetter;	24/10/2014

13	AIMPLAS desarolla barreras funcionales para el uso de materiales reciclados en envases multicapa para alimentación (in Spanish)	ENVAPACK - NewsLetter ENVAPACK	22/10/2014
14	Aimplas desarolla barreras funcionales para el uso de materiales reciclados en envases multicapa para alimentación (in Spanish)	Interempresas PLASTICO	21/10/2014
15	Functional Barriers in Multilayer Food Packaging	Packaging Europe	20/10/2014
16	Noticias y actualidad sobre empresas de tecnología de alimentos (in Spanish)	TECNOALIMEN – INFOEDITA;	20/10/2014
17	Aimplas desarolla barreras funcionales para el uso de materiales reciclados en envases multicapa para alimentación (in Spanish)	ENVAPACK	20/10/2014
18	EL PROYECTO BANUS AVANZA EN EL USO DE MATERIALES RECICLADOS EN ENVASES DE ALIMENTOS (in Spanish)	Residuos Profesional WEB	17/10/2014
19	Ailnplas desarrolla b arrer as funcionales para envases multicapa (in Spanish)	Alimarket web - NewsLetter	17/10/2014
20	Nueva generación de envases para alimentación con materiales reciclados (in Spanish)	Econoticias	17/10/2014
21	AIMPLAS desarolla barreras funcionales para el uso de materiales reciclados en envases multicapa para alimentación (in Spanish)	Agronoticias; Alimarket web; AMBIENTE PLASTICO; RETEMA	17/10/2014
22	Aimplas desarolla barreras funcionales para el uso de materiales reciclados en envases multicapa (in Spanish)	Profesionales Hoy; InnDEA Valencia – NewsLetter; InnDEA Valencia ;	16/10/2014
23	Red de Innovación del Sector Agroalimentario (in Spanish)	InnDEA Valencia	16/10/2014
24	Barreras funcionales para el uso de materiales reciclados en envases multicapa para alimentación (in Spanish)	Eurocarne Digital	16/10/2014
25	AIMPLAS desarolla barreras funcionales para el uso de materiales reciclados en envases multicapa para alimentación (in Spanish)	Notiplastic Boletin	16/10/2014
26	Avep participa en el proyecto de investigación Europeo BANUS (in Spanish)	AVEP (newsletter) (page 6) http://issuu.com/avepinfo/docs/avep_n__100_issuu	13/10/2014

27	Official project website	BANUS website http://banus-project.eu	September 2014
28	BANUS promotion (in Spanish)	http://www.avep.es/banus/	September 2014
29	Functional barriers in food packaging using recycled materials to be developed in new EU project, Banus	INNVENTIA website (www.innventia .com)	10/11/2014
30	Ongoing project BANUS BANUS (in Swedish)	http://www.innventia.com/en/Projects/Ongoing-projects/Banus/ http://www.innventia.com/sv/Exempel-pa-projekt/Aktuella-projekt/Banus/	10/10/2014
31	About BANUS on Facebook: Innventia is a part of the new EU Project Banus	https://www.facebook.com/permalink.php?id=121412087927365&story_fbid=724105404324694	30/10/2014
32	About BANUS on Facebook: More about the EU Project Banus	https://www.facebook.com/permalink.php?story_fbid=730294633705771&id=121412087927365	10/11/2014
33	About BANUS on Twitter: More about the EU Project Banus	https://twitter.com/innventia/status/531818090112495617	10/11/2014
34	EU-projekt ska utveckla funktionella barriärer till livsmedelsförpackningar (in Swedish)	http://www.packnyheter.se/default.asp?id=7832&show=more	17/11/2014
35	EU-projekt ska utveckla funktionella barriärer till livsmedelsförpackningar (in Swedish)	http://skogssverige.se/kategori/livsmedelsforpackning	18/11/2014
36	AVEP presentó en Emballage sus proyectos: GREENPACK Y BANUS (in Spanish)	(page 19) http://issuu.com/avepinfo/docs/avep_101_enero_2015_issus/0?e=7013109/10729472	January 2015
37	Development of functional barriers for the use of recycled materials in multilayer food packaging (press release on a website)	ECP4 website http://www.ecp4.eu/news-events/news/	13/01/2015

38	AVEP. Se reunen los consorcios de los proyectos europeos en los que participa AVEP	(page 11) http://issuu.com/avepinfo/docs/avep102_issus	01/04/2015
39	AIMPLAS anuncia su presencia en Hispack 2015 PLA4FOOD, BANUS y BIO4MAP.	MUNDOPLAST	10/04/2015
40	AIMPLAS. Desarrollo de estructuras multicapa	http://www.automaticaeinstrumentacion.com/es/notices/2015/04/hispack-acogera-la-innovacion-en-envases-de-plastico-desarrolladas-por-aimplas-42871.php	14/04/2015
41	AIMPLAS presentará sus últimos proyectos en Hispack	ALIMARKET Envase	15/04/2015
42	AIMPLAS participa en HISPACK con sus proyectos en envases activos, reciclados y biodegradables	http://www.ecoticias.com/residuos-reciclaje/102188/AIMPLAS-participa-HISPACK-proyectos-envases-activos-reciclados-biodegradables	16/04/2016
43	AIMPLAS en EMPACK Portugal	Mudoplast.com	21/09/2015
44	AIMPLAS presenta sus innovaciones en envase en EMPACK	Interempresas.net	25/09/2015
45	AIMPLAS. BANUS, proyecto de investigación para las PYMEs financiado bajo el Séptimo Programa Marco	CTC Alimentación	22/12/2015
46	AVEP. Diseminación del Proyecto BANUS en la feria “Made from plastic”	(page 11) https://issuu.com/avepinfo/docs/avep_105_enero_2016	01/01/2016
47	CTC. Direct link to BANUS website on CTC website	http://www.ctnc.es/proyectoseuropeos/banus	01/01/2016
48	AIMPLAS. Innovaciones sostenibles en envases de plástico	Revista de plásticos modernos Vol. 111 Número 710	01/03/2016
49	AVEP. Envases multicapa a partir de material reciclado en OK PLAST: resultados de BANUS	(page 9) https://issuu.com/avepinfo/docs/avep_web-3	01/05/2016

50	AVEP.The Banus project press release will be published in quarterly AVEP Magazine	AVEP magazine	01/06/2016
51	CTC. Article and advertisement in technical magazine CTC Alimentación	Magazine CTC alimentación	30/06/2016
52	BUMAGA. booklet on bio barriers in which we will include public conclusions and next steps from BANUS project	http://www.bumaga.nl/	01/09/2016

Exhibitions, Fairs, Workshops, Conferences			
01	Banus presentation at AVEP booth in Emballage fair (Leaflet dissemination)	http://www.all4pack.fr/salon-emballage	21 to 22/10/2015
02	EQUIPLAST fair	Barcelona, Spain	End Sep-Beginning Oct 2014
03	Pack Experience by HISPACK-Los envases de 2020 (Info day managed by AIMPLAS)	AIMPLAS, Spain	16/10/2014
04	Sustainability Info-day (generic presentation of the BANUS Project)	Madrid, Spain	20/11/2014
05	II Encuentro sectorial el Instituto español del envase y embalaje: Reducción de costes. Nuevos Materiales-General Promotional Project slide	Fira de Barcelona (Spain)	30/1/2015
06	Flexible Packaging Europe (FPE) Technical Workshop-(generic presentation of the BANUS Project and leaflets delivery)	Dusseldorf (Germany)	26-27/03/2015
07	BUMAGA. Innovative paper and board based food packaging	Den Bosch, The Netherlands	15/04/2015
08	AIMPLAS. Ponencia Eva Verdejo Hispack 2015	Trendpack- Hispack Barcelona	21/04/2015
09	AIMPLAS. Workshop Estructuras multicapa PLA4FOOD, BANUS y BIO4MAP		

10	AVEP. Banus presentation at AVEP booth in Plastic Expo - Tunis fair (Leaflet dissemination)	Milan	05-09/05/2015
11	AVEP. Banus presentation at AVEP booth in Plastic Expo - Tunis fair (Leaflet dissemination)	Tunis	13-16/05/2015
12	BUMAGA. "Food contact materials; what makes a functional barrier and how to use this?" (Bumaga presents at meeting organised by FNLI)	Bunnik, The Netherlands	20/05/2015
13	AVEP. Banus presentation at AVEP booth in Plast Expo - Morocco fair (Leaflet dissemination)	Morocco	03-06/06/2015
14	AVEP. Banus presentation at AVEP booth in Made from Plastic fair (Leaflet/poster dissemination)	Valencia	21-22/10/2015
15	All partners: Workshop, How can we treat plastics (in raw materials and laminates) in the paper and board chain in a smarter way?'	BUMAGA	28/10/2015
16	KCPK and Bumaga present their work to the Dutch paper industry incl work on BANUS	BUMAGA	02-03/02/2016
17	AVEP: Banus presentation at AVEP booth in Plast Argel (Leaflet/poster dissemination)	AVEP	05-07/04/2016
18	AIMPLAS. Tendencias y oportunidades de innovación ambiental en materiales y productos plásticos	Universidad de Colombia	21/04/2016
19	AIMPLAS. OKPLAS	AIMPLAS	24-25/06/2016
20	AVEP. Pleanry meeting	AVEP	26/05/2016
21	BUMAGA. BANUS will be presented during a workshop on Circular Economy	Netherlands	31/05/2016
22	BUMAGA. BANUS will be presented during a session on mineral oil migration	Netherlands	09/06/2016
23	AVEP. Banus presentation at AVEP booth in GO GLOBAL	AVEP	29-30/06/2016
24	AVEP. Banus final results at AVEP booth in K 2016 fair	AVEP	19-26/10/2016

25	AVEP. Banus final results at AVEP booth in Emballage fair	AVEP http://www.all4pack.fr/salon-emballage	14-17/11/2016
26	BUMAGA. Bio barriers workshop organised by Bumaga	BUMAGA	15/06/2016
27	BUMAGA. Bumaga will represent BANUS at conference Packaging Industry	http://www.packagingcongres.com/	16/06/2016
28	INVENTIA. Conference "TAPPI Advanced Coating Symposium"	Inventia http://www.tappiadvancedcoating.org/	04-06/10/2016
Dissemination material			
01	Project leaflet (EN version)	To be delivered in all suitable events, to be printed by each of the Project partners.	September 2014
02	AIMPLAS. Desarollo de barreras funcionales para el uso de materiales reciclados en envases multicapa para alimentación.	CONAMA	07/10/2015
03	CTC. Poster of BANUS on GOOD HERBS International Conference	Bucharest, Romania	15-16/06/2016