



AWeSOMe

Agricultural Waste as Sustainable 0 km building Material

DELIVERABLE O.T2.1

PILOT LAB ON SUSTAINABLE MATERIALS

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1. Introduction

The project AWeSOMe - Agricultural Waste as Sustainable 0 km building MatERial is aimed to spread the best practices about the use of agricultural waste for producing bio-based building components with high hygrothermal performances. The goal of the project arises in response to the Energy Performance of Buildings Directive (EPBD 31/2010) which requires an improvement of the building's energy performance in view of being nZEB. The increase in building energy efficiency is strictly associated with the environmental safeguard obtained by the use of agricultural by-products and low environmental impact manufacturing processes.

The specific project objectives are the following:

- Improving the implementation of Sustainable Energy Actions for buildings in the public sector;
- Enhancing skills in low environmental strategies such as the use of agro-waste for efficient buildings;
- Promoting the use of agricultural waste in the building sector.

This document presents an overview of activities carried out within WP2, aimed at the implementation of Pilot Labs where the potential of agro waste for the use in building materials was promoted.

2. WP 2 Pilot Action

The main output of this WP was the setup of pilot labs (one for each Project Partner) aimed at the production and implementation of prototypes and demonstrators capable of showing to a broader audience that agro-waste based materials can be practically used and to validate their energetic performance by means of instrumental measures, possibly shown during “live” sessions and “living laboratories” activities.

In addition, in order to show that use of agro-waste to produce building materials can be carried out at both the industrial and craftsman scale, self building sessions were planned to stimulate, in particular the involvement of the farmers and the main producers of agro-waste, as well as to promote the culture of the sustainability and circularity to a broader audience.

WP activities were subdivided into the following sub tasks:

- 1) Activity T2.1 Analysis of the state of the art of local agro-waste
- 2) Activity T2.2 Concept design
- 3) Activity T2.3 Implementation of the prototypes
- 4) Activity T2.4 Self-building agro-waste materials

2.1 Activity T2.1 Analysis of the state of the art of local agro-waste

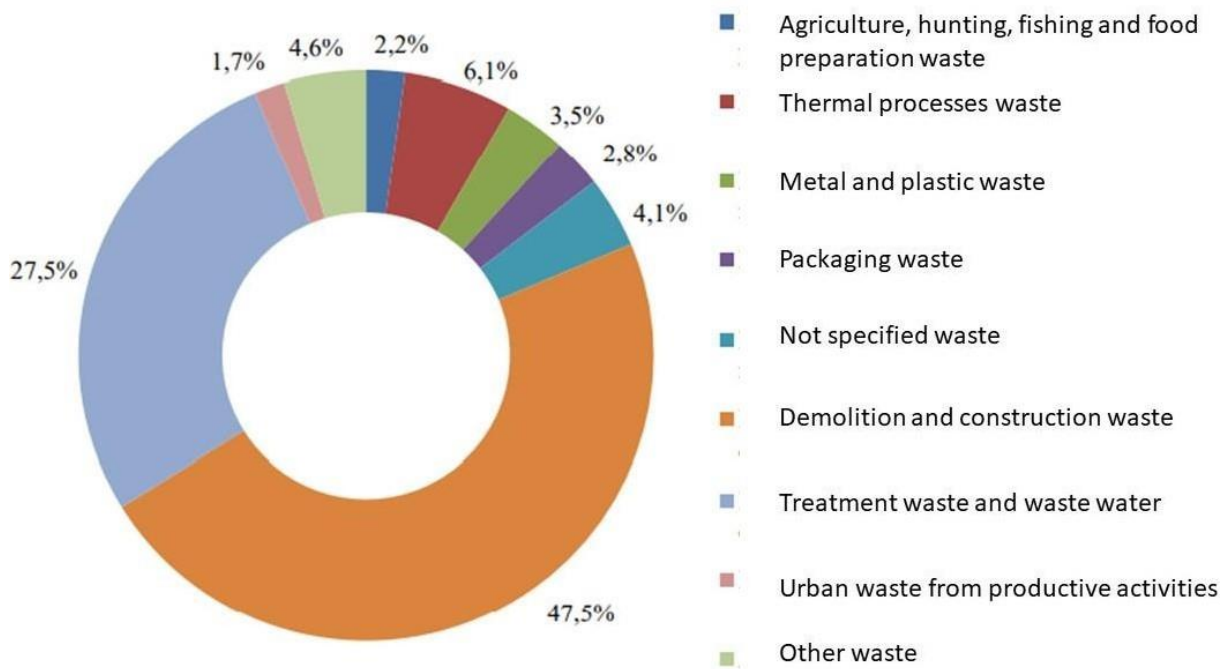
This activity consisted in performing an analysis of the state-of-the-art of the main agro-waste available in the involved Regions, and considering the suitability of these residues to be used as new raw materials for the production of building components. The main goal of this activity was the production of a snapshot of the current regional situation regarding the availability and the technical eligibility of the agro-waste in the building sector.

Availability on the market of products already based on the use of agro-waste were also investigated, in order to avoid duplication and possibly use them in the subsequent steps and in particular in the realization of building prototypes and demonstrators.

2.1.1 Deliverable D.T2.1: Report on available agro-waste

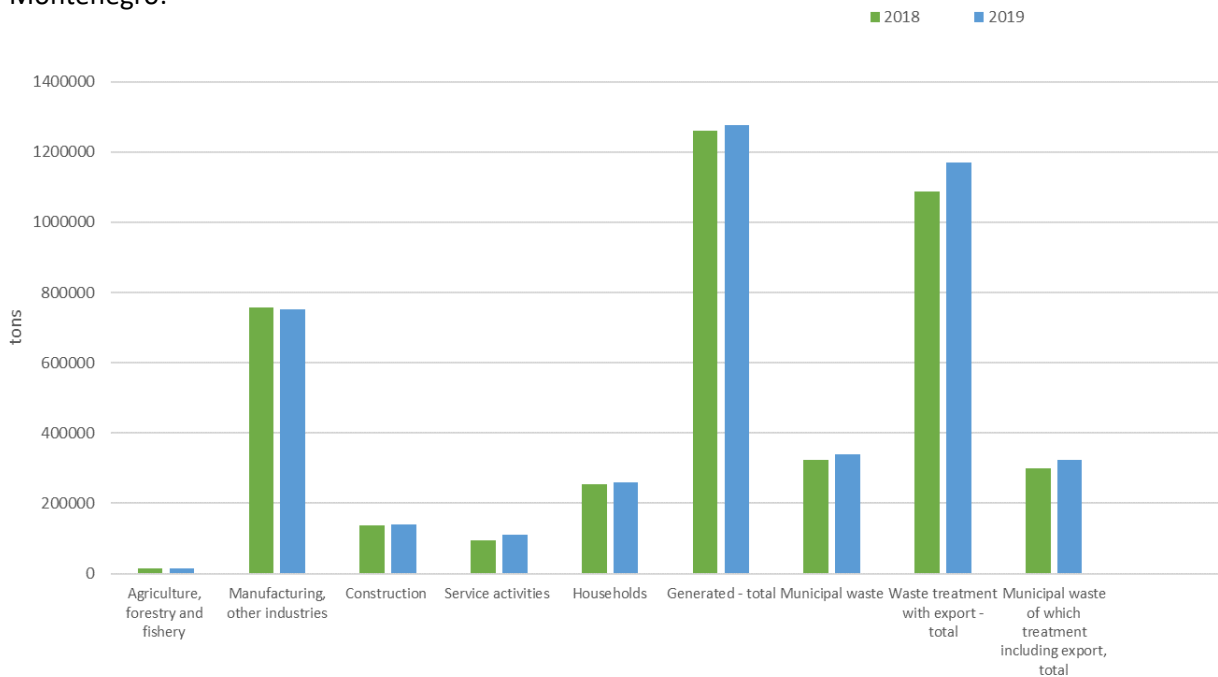
The report summarized the agro-waste available in each region in order to identify which residues could be inserted in a circular economy system and could be suitably reused as raw materials for the production of building components. (Annex 1)

Italy: Puglia and Molise

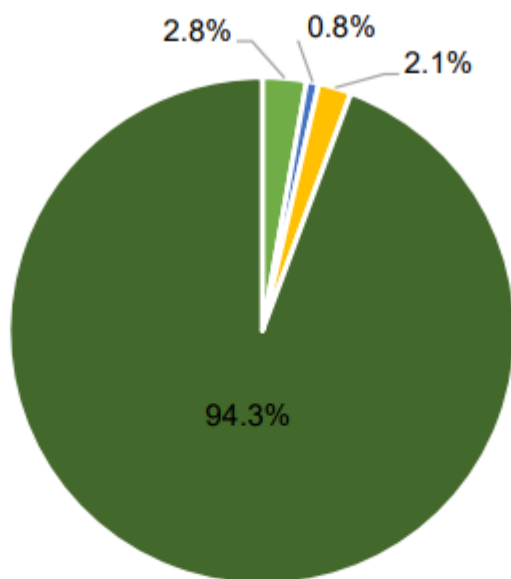


Italy, percentage repartition of not hazardous urban waste per waste type (Adapted from: Rapporto rifiuti speciali, ISPRA Edizione 2021)

Montenegro:



Montenegro: Generated and treated amounts of waste, 2018 and 2019 (Adapted from MONSTAT, Montenegro statistical office release No. 218 Podgorica, 29 December 2020)

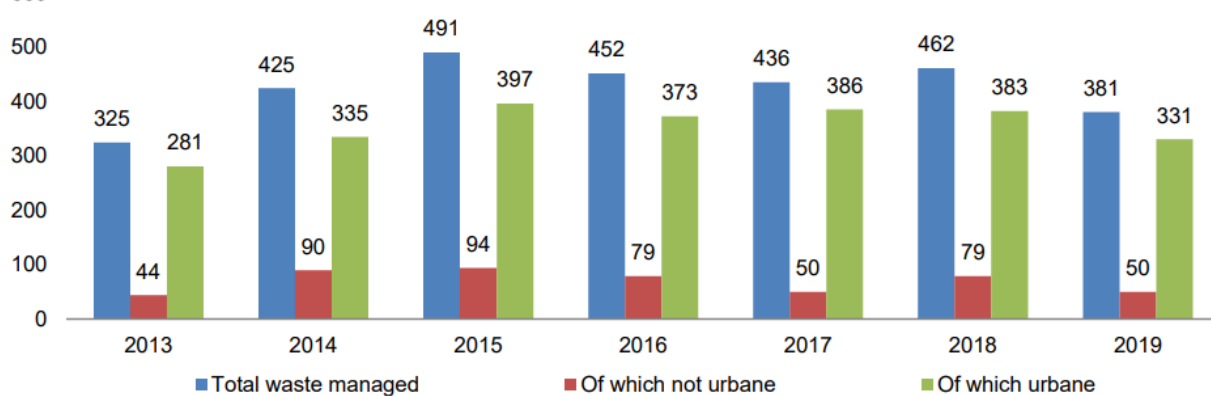


- Arable land
- Permanent crops
- Kitchen gardens and/or gardens
- Perennial meadows and pastures

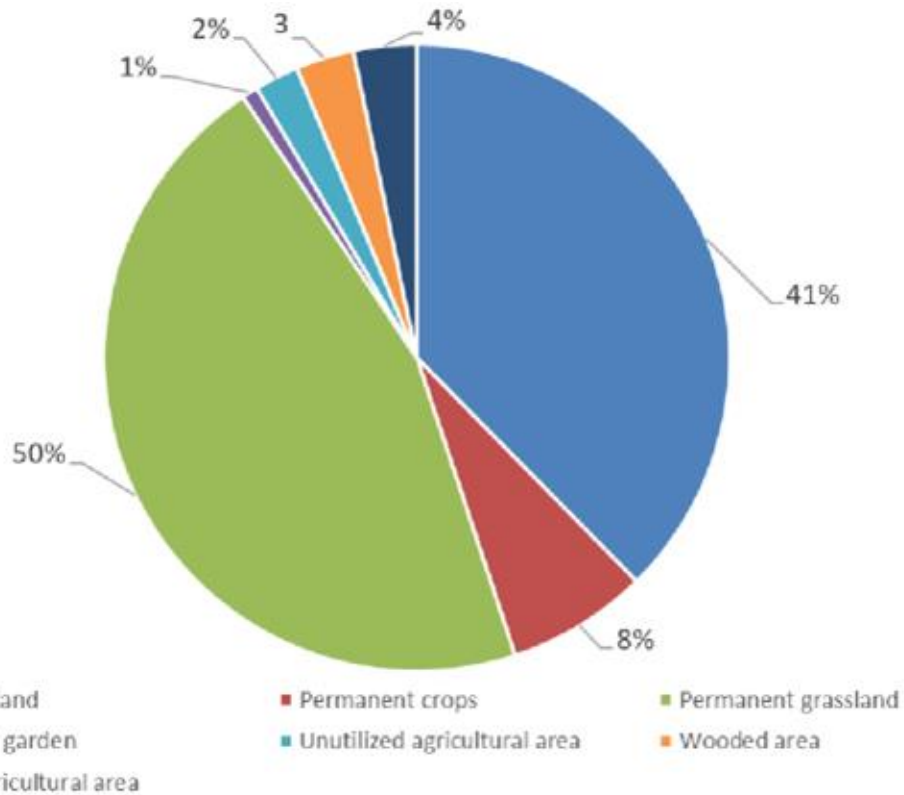
Montenegro. Utilised agricultural area, 2019

(Source: MONSTAT, Montenegro statistical office release no. 117 Podgorica, 1 July 2020)

Albania:



Total urbane waste managed by generating resources (kg/capita) (Source: INSTAT, 2020).



Albania, Utilised agricultural area, 2020 (Adapted from INSTAT, Institute of Statistic, 2020).

In addition to the internal report, taking advantage of the collected information, the following paper was published in the journal Sustainability (Annex 2):

Stefania Liuzzi; Chiara Rubino; Pietro Stefanizzi; Francesco Martellotta. *The Agro-Waste Production in Selected EUSAIR Regions and Its Potential Use for Building Applications: A Review*. Sustainability 2022, 14, 670 .

2.2 Activity T2.2 Concept design

The activity was related to the definition of the structural and hygrothermal properties that agro-waste building components, to be developed or used in the prototypes, were expected to have. A detailed snapshot of the specific requirements and technical was produced. In particular, a list of the relevant physical properties that play a crucial role for such group of materials was identified: Density, Porosity, Thermal conductivity, Diffusivity, Specific heat, Vapour permeability and resistance, Flexural strength, Elasticity modulus, and fire rating, were included in the list. Possible applications were identified in terms of plaster and mortars, bricks, insulating materials, and loose insulators, and for each category, possible reference values were given as a guideline.

2.2.1 Deliverable D.T2.2 Report on the requested properties

A detailed snapshot of the structural and hygrothermal properties has been produced in the form of guidelines for the realization of energy-efficient building components. (Annex 3)

2.3 Activity T2.3 Implementation of the prototypes

This activity dealt with the development and deployment of the four pilot prototypes in public (and representative) buildings including the purchase of the equipment (thematic equipment) necessary to perform hygrothermal and physical characterization of the installed materials. The four prototypes, also realized by means self-building technique, were installed in representative areas of public buildings in order to ensure visibility and stimulate a broader audience on the topics of circularity and sustainable use of natural resources.

Different approaches were selected by the different partners, so that a diverse and multifaceted situation was represented. In fact, Albania used rice straw thermal insulating panels, Apulia used prefabricated straw bricks and self-made straw insulation, Montenegro used loose straw finished in agro-waste based cardboard panels, Molise used self-made straw insulation.

Specific presentation events were organized in each Region to present the prototypes to the general public and, more importantly, to the stakeholders. During these events, in addition to presentation workshops were the use of agro-waste in the building sector was promoted, “living-labs” were organized in the form of guided visits to the pilot actions (Puglia, Montenegro and Albania), self-building workshops (Molise), on-site measurement sessions (Puglia).

In fact, to assess the effective energy saving resulting from use of bio-based building component, each Project Partner used monitoring tools, including infra-red cameras, thermal conductivity meters, indoor environment probes that allowed to provide a picture of the actual properties of such materials. Due to time limitation, not all the partners managed to complete the measuring campaigns, but a sufficiently detailed picture was outlined.

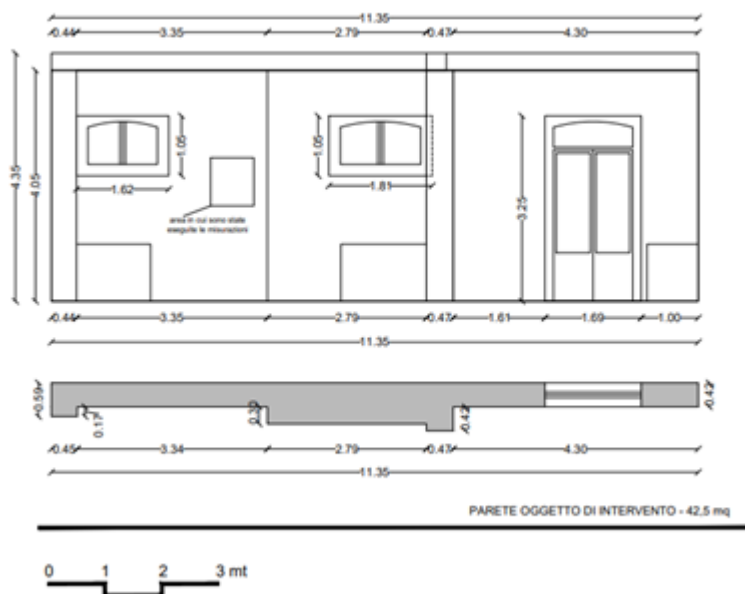
2.3.1 Deliverable D.T2.3 Prototypes

The deliverable summarizes the main features of the prototypes realized in each territory, the events that were organized for their presentation and, if available, summarized the measured properties. (Annex 4)

Puglia:



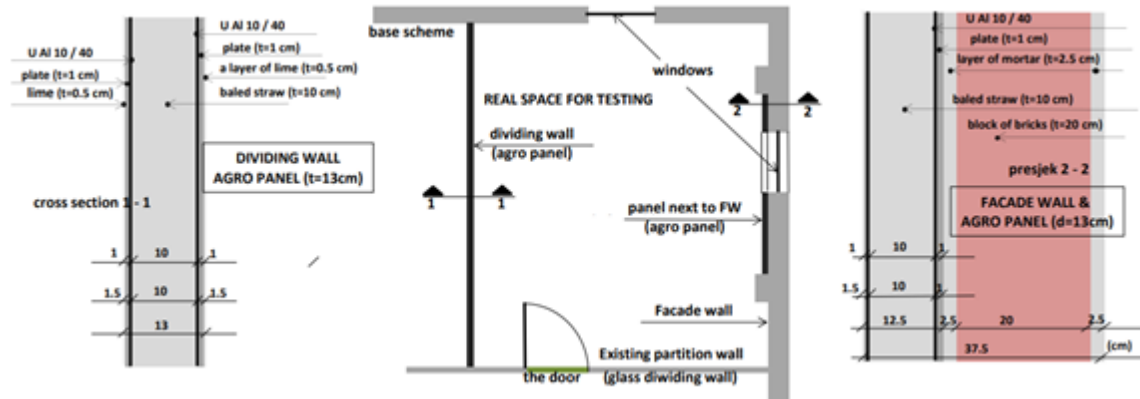
Molise:



Albania:



Montenegro:



2.4 Activity T2.4 Self-building agro-waste materials

The scope of this Activity was to involve communities and possibly farmers in public events to demonstrate self-building potentials, and explain environmental advantages of proposed technologies. This activity has been developed by PP4 (GAL Molise verso il 2000) with the supervision of PP2 (Politecnico di Bari) and was described in detail in the Deliverable DT2.3.

Conversely, the two deliverables that were associated to this Activity were meant to provide a preliminary description of the materials and methods that can be used in the self-building practices to also ensure that the building elements comply with regulations and have the expected performance (D.T2.4.1), and to provide a preliminary characterization of thermal properties carried out in the Laboratory on self-made agro-waste panels, that could be potentially used in subsequent actions.

2.4.1 Deliverable D.T2.4.1 Report on self-building practices

This report summarized the typologies and methods more frequently used in self-building practices, mostly using straw (as this was identified as the most frequently used and practical to handle, among the different available agro-waste, as well as being available in all the projects' regions). As self-building practices are more likely to be used by farmers or in contexts where regulations allow such materials, the selection was made having in mind such issue, but specific properties to be met were also defined.

(Annex 5)

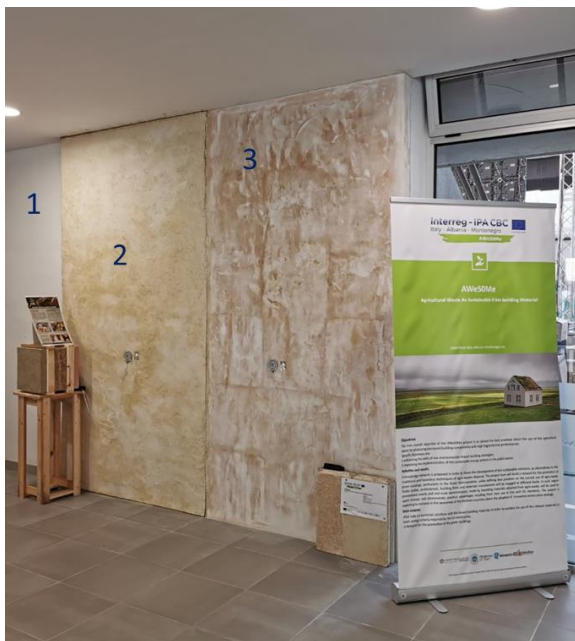
2.4.1 Deliverable D.T2.4.2 Agro waste based panels

Different kind of agro-waste (almond skin, olive pruning waste, straw) were selected in laboratory to create samples suitable as aggregate for thermal insulation building components. Thermal conductivity, thermal diffusivity and volumetric heat capacity were measured. The results demonstrates that the agro-waste have a great potential to enhance the final thermal performances of the materials assuring high thermal comfort in the same way as common traditional material currently existing on market (e.g. EPS panels).

(Annex 6)

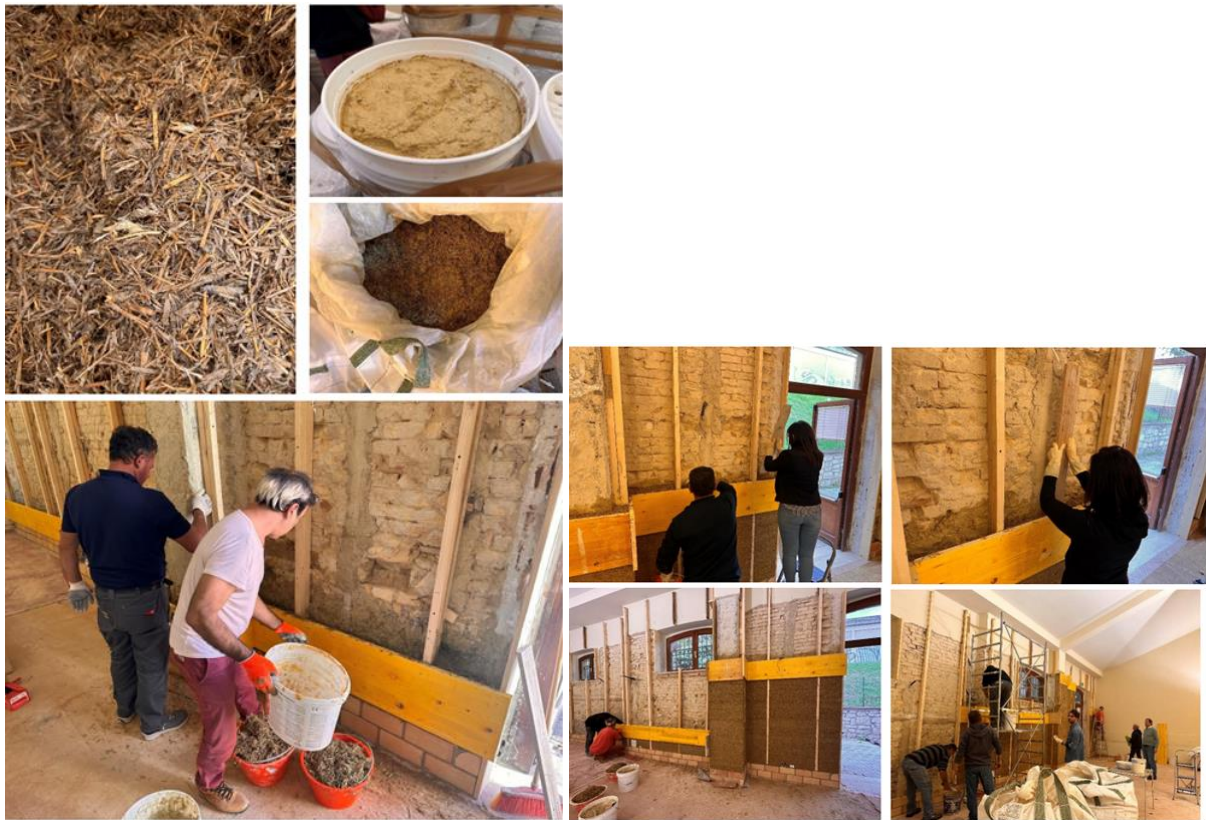
Puglia:





Molise:



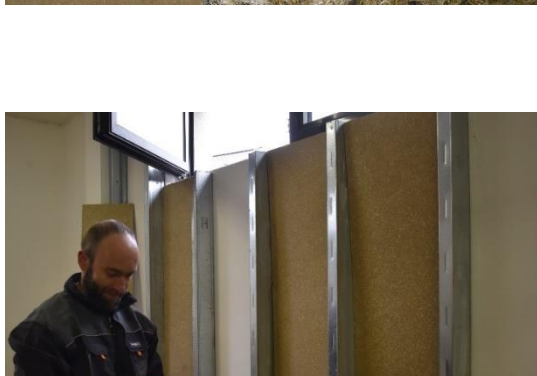
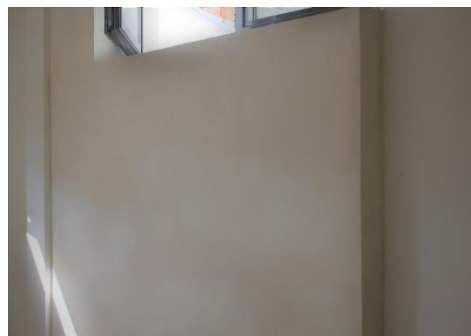


Albania:





Montenegro:



3. Target groups that have been reached

Target groups addressed thanks to the activities developed in the project and in the Pilot Actions:

Municipalities [4]

1. Municipality of Mola di Bari¹
2. Municipality of Corato¹
3. Municipality of Bari⁴
4. Municipality of Niksic²
5. Municipality of Mirabello Sannitico (CB)³

Public bodies [4]

1. Ministry of Agriculture of Albania^{2,3}
2. Puglia Region, Economical development Department^{2,3}
3. Puglia Region, Agriculture, rural development Department²
4. Puglia Region, Dept. Environment, Landscape and Urban Quality³
5. Engineering chamber of Montenegro²

Farmers' NGOs. NGOs of building contractors, interest groups of architects and engineers. [10]

1. Build Green Albania, Tirana (NGO)¹
2. Bari province Charter of Engineers^{1,2}
3. Bari Province Charter of Architects and Urban planners^{1,2}
4. Apulian District of Sustainable Buildings^{1,2}
5. Apulian District of New Energies^{1,2}
6. Local Action Group "Terre di Murgia"¹
7. Order of architects of Campobasso³
8. Order of agronomist of Molise³
9. Order of engineers of Campobasso³
10. UNPLI Molise (Unione delle PRO LOCO del Molise).³

Business support organizations [2]

1. Unioncamere Puglia³
2. Associazione Produttori Esportatori Ortofrutticoli (APEO)^{2,3}
3. Coldiretti Puglia⁴
4. Lega COOP Molise - Association of the cooperatives of Molise³
5. JUST MO - Association³
6. GAL Molise Verso il 2000 - Partner of AWeSOMe and also business support organization³
7. Coldiretti Molise - Support organization for the Farmers of Molise³

Education and training centers [2]

1. Panetti-Pitagora Technical and Technological Institute, Bari³
2. De Nittis-Pascali Artistic High School, Bari³
3. High School for geometri "Istituto Tecnico Costruzioni, Ambiente e Territorio", Campobasso³
4. High School "Istituto Professionale per l'Agricoltura e lo Sviluppo Rurale", Campobasso³

Universities and research centers [2]

1. Polis University Tirana¹
2. Tirana Business University College¹
3. Epoka University, Tirana^{2,3}
4. Università degli Studi di Bari "A. Moro", Dip. di Scienze Agro Ambientali e Territoriali^{1,2,3}
5. Politecnico di Bari (Research Groups other than PP2)^{1,2,3}
6. Università del Salento¹
7. Consiglio Nazionale delle Ricerche, Istituto per le Tecnologie della Costruzione, Bari¹
8. CREA, Consiglio per la ricerca in agricoltura e l'analisi dell'economia agraria, Sede di Turi³
9. Università del Molise³
10. Faculty for Civil Engineering, Podgoriza University²

SMEs [15]

1. Hackustica, San vito dei Normanni^{1,3}
2. Materias, Napoli¹
3. Prespaglia, Modugno^{1,2,3}
4. Terrabuildingdesign, Ceglie Messapica^{2,3}
5. Alfrus srl, Modugno²
6. Burdi srl, Ceglie del Campo (BA)³
7. Ricehouse, Andorno Micca (BI)³
8. Frantoio D'Orazio, Conversano⁴
9. Paper Factor, Lecce⁴
10. Adriatica Legnami, Fasano⁴
11. Ditta Giovanni Iacobucci srl³
12. Ditta Pasquale Sardella³
13. Ditta Luca Simone³
14. Ditta Atena Engineering³
15. Ditta Giuseppe Di Paola Costruzione srl³
16. Ditta Califel srl³
17. Cipranic Company, Montenegro²
18. EPCG, Montenegro²
19. Meditera, Montenegro²
20. 13. Jul Plantaze, Montenegro²

¹⁾ Attended Kick-off meeting

²⁾ Attended thematic workshops

³⁾ Attended Pilot Action presentation

⁴⁾ Contacted and interested in the project, but couldn't attend any event

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