



D6.5 PestNu Digital Platform [2]

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Topic: LC-GD-6-1-2020: Testing and demonstrating systemic innovations in support of the Farm-to-Fork Strategy

Subtopic C. [2021] Reducing the dependence on hazardous pesticides; reducing the losses of nutrients from fertilisers, towards zero pollution of water, soil and air and ultimately fertiliser use

List of Abbreviations & Definitions

Abbreviation	Definition
ABS	Acrylonitrile Butadiene Styrene
AGV	Automated Guided Vehicle
AI	Artificial Intelligence
AOP	Agro-ecological and Organic Practices
API	Application Programming Interface
AR	Augmented Reality
B2B	Business-to-Business
B2C	Business-to-Consumer
CV	Curriculum Vitae
D	Deliverable
DB	Database
DoA	Description of the Action
DSS	Decision Support System
DST	Digital and Space-based Technologies
EC	European Commission
EU	European Union
F2F	Farm to Fork
FAQ	Frequently Asked Questions
HTTP	Hypertext Transfer Protocol
IAB	Industrial Advisory board
IoT	Internet of Things
IP	Internet Protocol
JSON	JavaScript Object Notation
LCA	Life Cycle Analysis
M	Month
MERN	MongoDB Express.js React.js Node.js
NGO	Non-Governmental Organization
PCo	Project Coordinator

PDF	Portable Document Format
PLA	Polylactic Acid
REST	Representational State Transfer.
SEO	Search Engine Optimization
SME	Small and Medium-sized Enterprises
T	Task
URL	Uniform Resource Locator
UVC	Ultraviolet C
VR	Virtual Reality
WP	Work Package

Executive Summary

The present document, Deliverable (D) 6.5, represents the second version of the PestNu Digital Platform developed on the M18 of the PestNu project. The platform serves as an essential resource for the Farm to Fork (F2F) community by providing agro-advisory and business services. As part of the Open Science and Innovation Actions Work Package (WP) 6, the deliverable is specifically associated with Task (T) 6.2, the “Digital Platform for Agro-advisory and Business service”.

In this updated version, the platform has been thoroughly analyzed, with a comprehensive analysis of all its services and pages. The document and its sections are well-organized, with a brief introduction to the project and the document’s structure in Section 1. Section 2, which provides a full analysis of the platform, is particularly noteworthy. This section covers the access to the platform, its design, and its structure. The platform is user-friendly, with all pages divided into subsections for easy navigation. Each element of the platform has been analyzed in great detail, including the “Home”, “About”, “News and events”, “Resources”, “Business and investment tool”, “Services”, “Sister projects”, “Industry Advisory Members (IAB) logos”, and “Contact” pages. Of particular interest is the business and investment tool, which has been developed using the MERN stack architecture. The architecture view of the tool is presented, along with information about the database that was formed during the development process. The authentication process used in the tool, along with its components such as the homepage, user profile, and chat feature, have also been analyzed. All of the agro-advisory and business services provided by the platform have been described in detail. These services include workshop results, best practices, market trends, national plants, training materials, an augmented reality training tool, online measurements from pilot sites, and frequently asked questions. In the concluding section of the document, Section 3, the importance of the PestNu Digital Platform to the F2F community and PestNu stakeholders is emphasized.

The document notes that the platform will continue to evolve, improve and update even after the project's end. D6.5 is a fully detailed overview of the PestNu Digital Platform and it provides in-depth information about the platform's architecture, services, and design, making it a valuable resource.

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1. Introduction

1.1. About PestNu

PestNu project aims to reduce the use of pesticides and fertilisers, as well as the loss of nutrients, by employing a systemic approach that involves field-testing and demonstrating Digital and space-based technologies (DST) and Agro-ecological and organic practices (AOP). The DST will be interconnected to a cloud-based farm management system that features a Decision support system (DSS), a blockchain-based system for DST data evidence, integrity, Artificial Intelligence (AI) models verification, and a cybersecurity platform. This will help prevent cyber-attacks and Internet of Things (IoT) vulnerabilities. The solutions will be tested in aquaponic and hydroponic greenhouse and open-field vegetable cultivation in Greece and Spain. A pesticide reduction program will evaluate the maximum residue and acceptable daily intake levels to ensure vegetable's food safety, and Life Cycle Analysis (LCA) activities will be performed. The collaboration among all F2F stakeholders and European Commission services will be strong throughout all these systemic approaches.

1.2. Purpose of this Document

The D6.5 presents the PestNu Digital Platform, which serves as the project's website, offers integrated services, has a secured document storage, and is organized into three distinct categories. These include a variety of pages and services available to the **general public**, a **matchmaking tool** providing investment opportunities that **requires registration**, and a **secure area** restricted to verified PestNu partners.

The platform provides a wealth of resources for the F2F community. These resources include **digitalization of workshop results**, which provide information and insights gathered from the PestNu project's workshops. The platform also provides access to **material on best practices**, such as manuals for farmers, to help promote more sustainable and eco-friendly agricultural practices. Additionally, users can access **market trends and sales**, which provide the latest forecasts for PestNu-related themes. The PestNu platform also contains the **sister projects** section that ensures the interconnection with other projects and the **National plans** section that presents all the national plans of the consortium's member countries, with links for easy access. The platform also provides **training materials** for the F2F community to help improve their skills and knowledge in the agricultural sector. Users can access an **augmented reality (AR) training tool** that presents a unique and interactive way to teach techniques for different cases. **Online measurements from pilot sites** of the PestNu project will be available, providing real-time data of the pilot sites. Finally, the platform includes a **frequently asked questions** and answers section, which is designed to offer helpful information and guidance to users as they navigate the platform. PestNu Digital Platform is the primary source of information for project stakeholders and will remain updated for five years after the project's conclusion.

1.3. Structure of this Document

This document is organized into four sections. Section 1 provides an overview of the PestNu project and its offerings to stakeholders and end-users, focusing on the most fundamental information. Section 2 delves into the digital platform's functions, components, and services in greater detail. Section 3 presents the main digital platforms tools, the business and investment opportunities tool and the AR training tool. Finally, Section 4 presents the document's conclusions.

2. PestNu Website

2.1. Access

The PestNu digital platform is accessible for everyone via the Internet. The selected Uniform Resource Locator (URL) of the website allows finding the page easily also via search engines. The most suitable domain name for the purposes of the PestNu was: <https://pestnu.eu/>. The PestNu digital platform is divided into the following three parts. The first area is open to all users and accessible without any restrictions. However, the second area is secured and exclusively accessible to PestNu's partners, where the project's private deliverables are stored. This restricted area ensures that sensitive information is only accessible to authorized personnel. The third area is the Business & Investment Opportunities Tool that requires registration. By separating the three areas in this way, PestNu can ensure that the data is adequately protected while still providing valuable information to the wider community.

2.2. Design

During Month (M) 3 of the project, the website was developed using Drupal and later changed to WordPress. WordPress provided a solid foundation for further development, with benefits including a user-friendly interface, customizable options, Search Engine Optimization (SEO)-friendly structure, security, and a large and active community of users and developers, making it a great option for developing the PestNu digital platform. Over time, the website evolved into a comprehensive digital platform for Agro-advisory and Business services by adding on all the necessary functions and components.

The digital platform is composed of three primary subcomponents. The first subcomponent is designed to be accessible to all users, without any restrictions, and features seven additional sub-components. These sub-components are titled 1) **About**, 2) **News & Events**, 3) **Resources**, 4) **Sister Projects**, 5) **IAB Members Logos**, 6) **Services**, and 7) **Contact**. Each of these sub-components will be examined in greater detail in the following sections. The second subcomponent is the secured area of the platform, which is designed to provide access to private deliverables. This area is only accessible to verified PestNu Consortium members. The third and final subcomponent is the Business & Investment Platform, which requires users to sign up and register to access it. Once registered, the tool is available for free use.

Overall, the digital platform has been developed with the aim of providing valuable resources and information to the PestNu's stakeholders. The architecture (Figure 1) that is preferred with the different subcomponents have been designed to cover different needs, with the platform's Business & Investment Opportunities Tool component being particularly useful to those interested in finding new Business Opportunities.

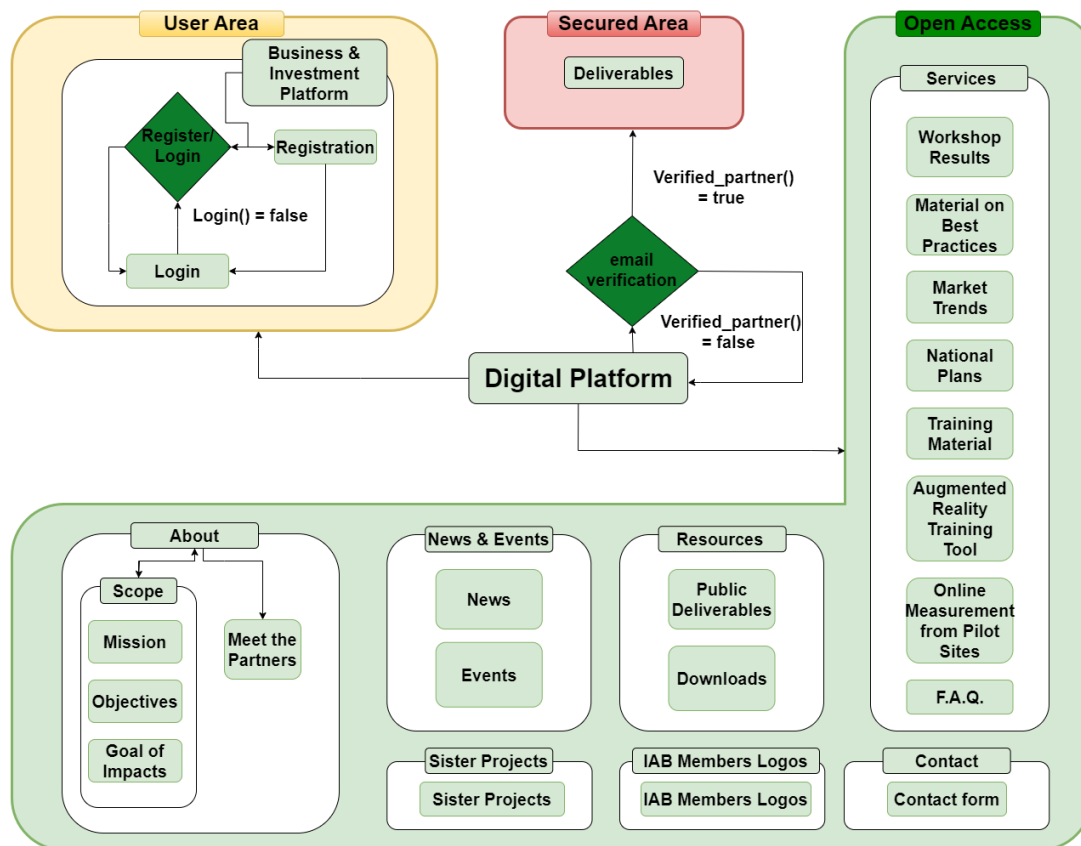


Figure 1: Digital Platform's Architecture View

2.3. Structure

The architecture of the digital platform is oriented in developing a widely accessible and user-friendly digital tool, that follows the sitemap below:

- Home
- About
 - Scope
 - Mission
 - Objectives
 - Goal of Impacts
 - Meet the Partners
- News & Events
 - News
 - Events
- Resources
 - Public Deliverables
 - Downloads
- Business & Investment Opportunities Tool

- Services
 - Workshop Results
 - Material on Best Practices
 - Market Trends
 - National Plans
 - Training Material
 - Augmented Reality Training Toolkit
 - Online Measurements from pilot Sites
 - F.A.Q.
- Sister Projects
- IAB Members Logos
- Contact

2.3.1. Home

The PestNu digital platform can be accessed through several methods such as typing the URL (<https://pestnu.eu>) into an internet browser, searching for it on a search engine, or by clicking on a link from a different website such as a partner website.

The development of the platform utilizes the signature colors of the logo - Light Green #a0c700, Dark Green #27ac88, and Blue #27acc2 - in order to create a visually appealing and user-friendly interface. The color scheme is integral to the overall aesthetic of the platform, and its consistent use reinforces the branding and enhances the user experience.

The homepage of the platform is a crucial aspect as it acts as the first point of interaction between the platform and its users. The PestNu's homepage presents the various features and tools offered by the platform. The importance of the homepage lies in its ability to provide a seamless and efficient user experience, allowing users to quickly and effectively engage with the platform's features and resources. The homepage of PestNu digital platform is the key component as it creates the first impression and sets the tone for the overall user experience. It is designed to provide clear and concise information about the platform's capabilities and make it easy for users to navigate and engage with its features, resources and services.

Screenshots of the platform's homepage (Figure 2) are presented to give a detailed look at its features and functionality. The homepage has been designed with a focus on providing a smooth and intuitive user experience.

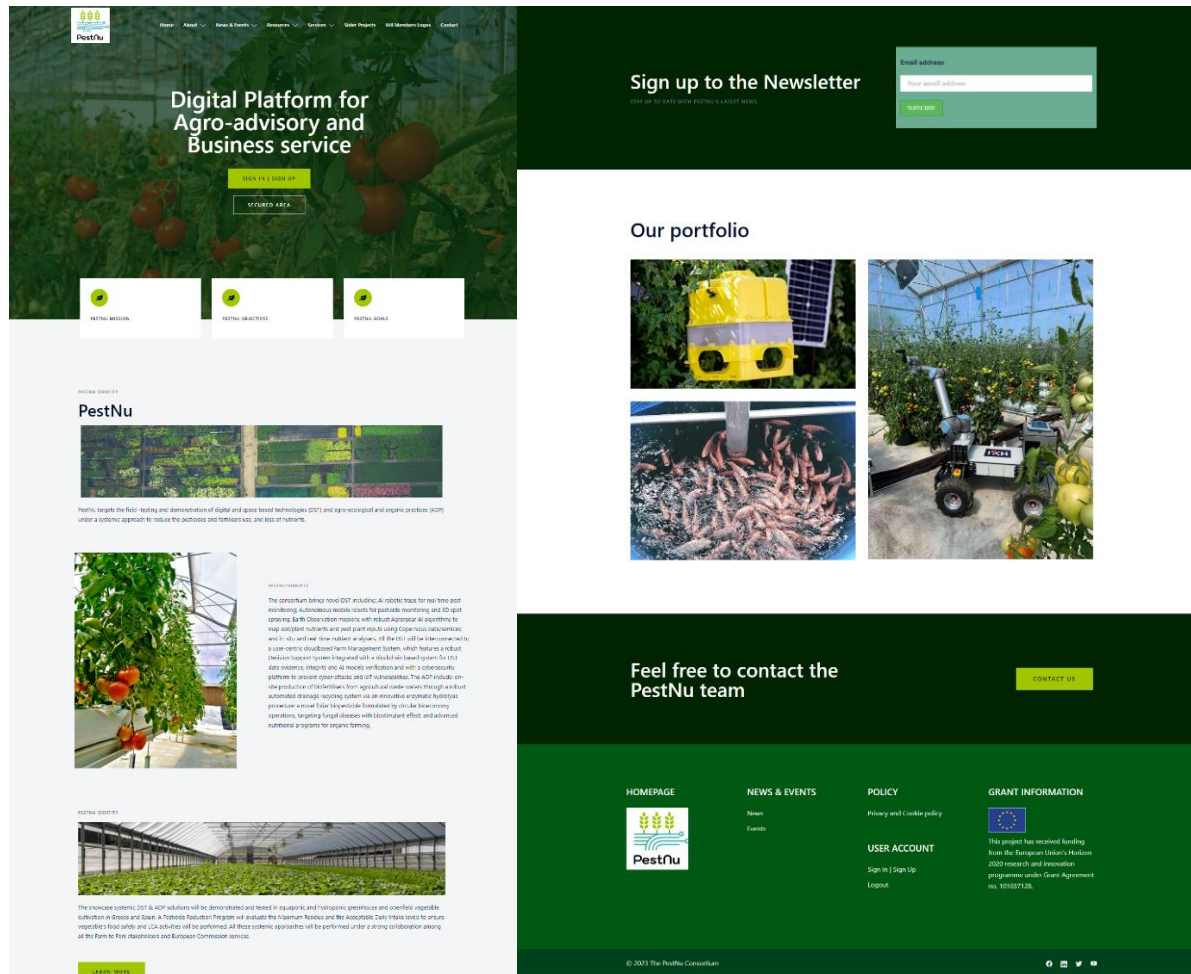


Figure 2: Screenshot of the homepage of the PestNu platform

The platform header is visible in all pages and includes the PestNu logo and the menu. The header is sticky and remains on the top of the webpage, so that the users can directly navigate through the platform’s different pages/services. The menu structure of the platform comprises of eight primary tabs, each offering a wealth of information and functionality. To further enhance the user experience and provide easier navigation, some of these primary tabs have been divided into sub-tabs, offering a focused approach to accessing the content of the pages.

The homepage of the PestNu project, offers an overview of the project with key details and presents images of the innovative tools developed. With specific links to detailed pages, visitors can delve deeper into the PestNu mission, objectives, and goals, stay up to date with the latest news, and easily access the contact page for getting in touch with the project. The homepage also provides the convenience of a newsletter registration function, allowing users to stay informed about developments and updates in the project.

When users visit the PestNu homepage, they will immediately see the "Sign In/Sign Up" button. This button, which is located below the text "Digital Platform for Agro-advisory and Business service," redirects users to the "Business & Investment Opportunities Platform," a matchmaking tool that will be analyzed further in the section 2.3.5.

On the homepage, a visible button labeled "Secured Area" provides access to a link containing all the private Deliverables, categorized by the Work Packages to which they belong. To gain access, partners

in the consortium must have filled out a file with their respective email addresses. Only those partners whose email addresses are listed in the file can access the Secured Area, otherwise the tab does not work.

The footer (Figure 3) consists of four columns and two rows. On the top row, first column, the PestNu logo is presented, note that the user can anytime navigate to the homepage by clicking the logo. On the second column, the “News & Events” shortcut is available, these categories will be further analysed in following sub-chapters (see 2.3.3.1 and 2.3.3.2). In the third and fourth column, the “Privacy and Cookie policy” and the Grant Information are presented, respectively. The Privacy and Cookie policy, redirects to another page to inform users about the collection, usage, and sharing of their personal data, as well as to comply with legal requirements. The Grant Information includes the acknowledgement of EU funding, specifically a flag and a text in line with the requirements from the European Commission. The bottom row consists of two columns. The first one presents the text for the PestNu digital platform Copyright and the second the social media of PestNu project, allowing the user to redirect to the project’s social media anytime.

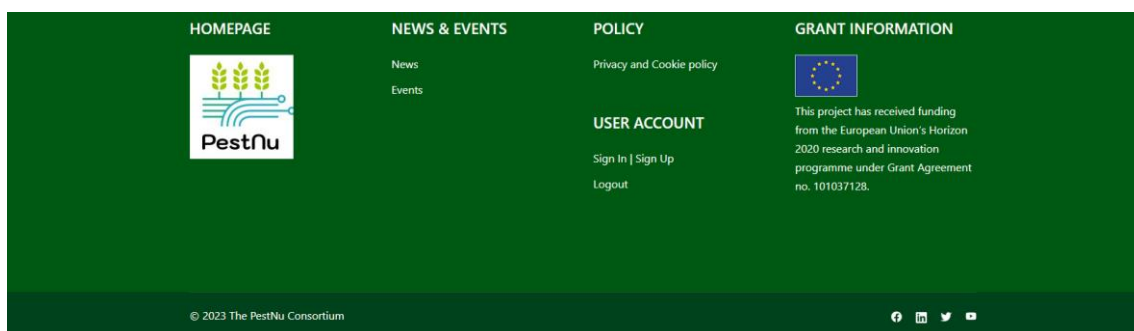


Figure 3: Screenshot of the digital platforms' footer

2.3.2. About

The section titled "About" of the PestNu digital platform, provides comprehensive and all-inclusive general information regarding the project. This section is further categorized into two sub-sections: "Scope" and "Meet the Partners". The "Scope" subsection is further segmented into three distinct components, namely the "Mission", "Objectives", and "Goal of Impact".

2.3.2.1. Scope

To enhance the user experience, the "Scope" section on the PestNu digital platform has been further divided into three sub-sections. This structure has been implemented to enable users to easily and quickly find the specific information they are looking for within the platform.

2.3.2.1.1. Mission

The "*Mission*" page includes the project mission: combination of DST and AOP to reduce dependence on hazardous pesticides and achieve less pollution of water, soil, and air in circular economy food production (Figure 4).

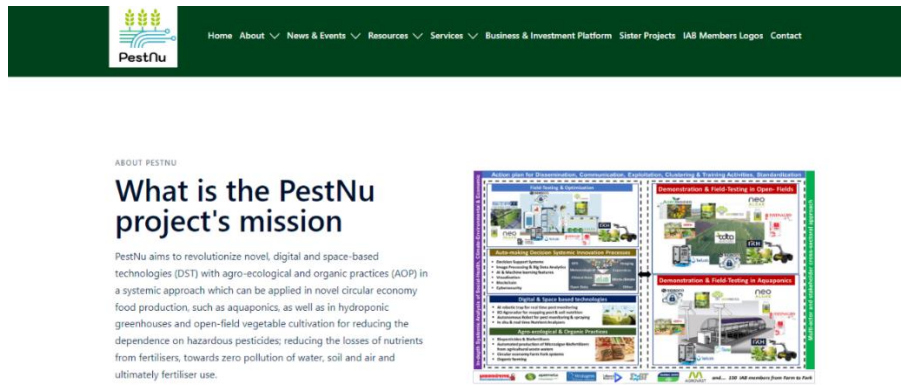


Figure 4: Screenshot of the “Mission” page of the PestNu digital platform

2.3.2.1.2. Objectives

The "*Objectives*" page on the PestNu Digital platform presents the PestNu’s main objectives as defined in the Description of the Action (DoA) (Figure 5).

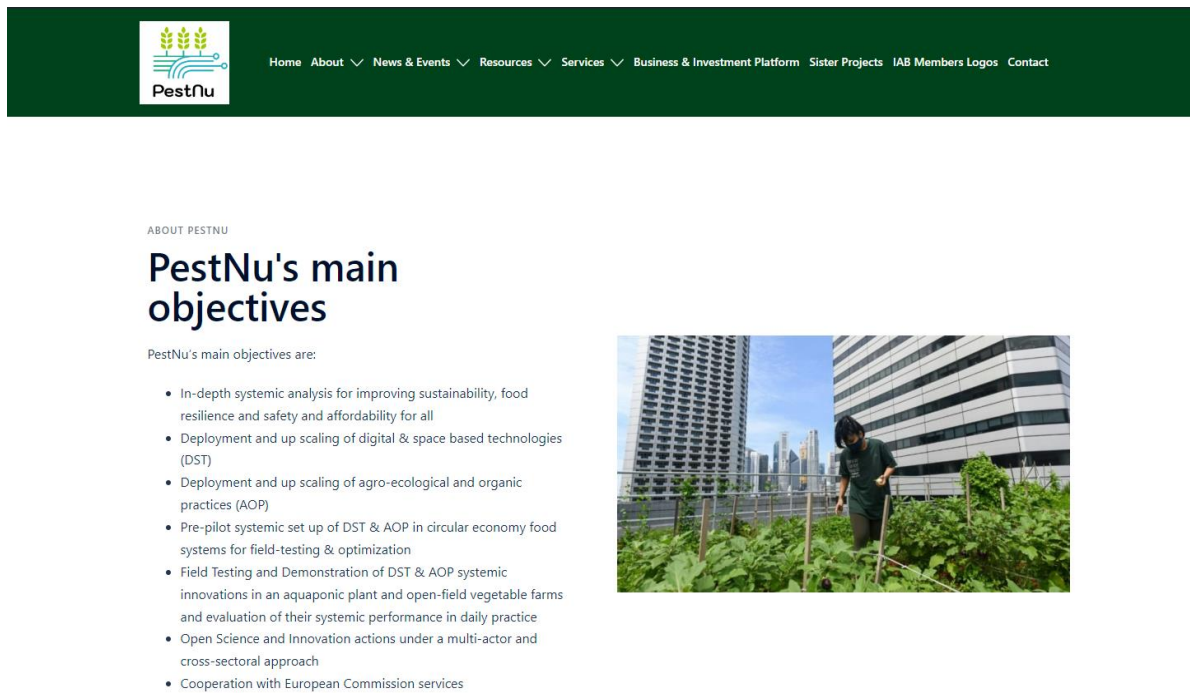


Figure 5: Screenshot of the “Objectives” page of the PestNu digital platform

2.3.2.1.3. Goal of Impacts

The "*Goal of Impacts*" page on the PestNu Digital platform outlines the PestNu’s core goals (Figure 6).



Figure 6: Screenshot of the “Goals of Impact” page of the PestNu digital platform

2.3.2.2. Meet the Partners

The PestNu project consists of 20 partners from 9 European Union (EU) countries, including Greece, Italy, Portugal, Spain, Cyprus, Austria, Ireland, and Sweden. The consortium is made up of 2 industrial partners, FERT and MAS, 10 small and medium-sized enterprises (SMEs), including TelLab, AgroINS, AgroROB, IKH, STAM, Neoalgae, Tilamur, SID, TRI, and STRATA, 5 non-governmental organizations (NGOs) and centre of agricultural, environmental, and food associations, such as CDTA, APEMETA, SEVT, GLOBAL, and Agrovast, 1 University, UTH, and 2 Research Centres, CERTH and RISE.

All of these aforementioned organizations are presented on the "*Meet the Partners*" page (Figure 7) of the PestNu website, which features the logo of each partner and a link to their website for easy access. Users can simply click on the link to be redirected to the partner's website in a new tab, where they can learn more about the organizations' work and expertise.

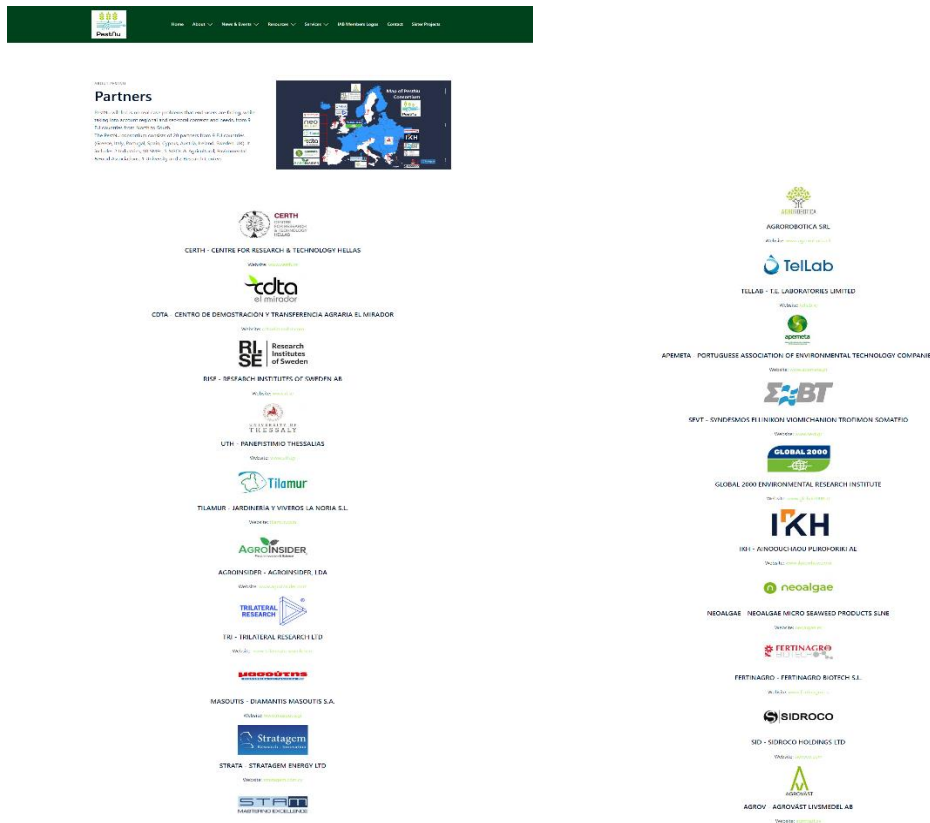


Figure 7: Screenshot of the “Meet the Partners” page of the PestNu digital platform

2.3.3. News & Events

The "News and Events" section of the platform encompasses all the relevant information necessary to keep users up-to-date with the project's latest developments. Users can easily navigate to each section and access events they may wish to attend or observe the project's progress.

2.3.3.1. News

The "**News**" category on the digital platform consists of short blog posts that are focused on the development of the PestNu project. This category covers various topics, such as publications, paper presentations, and events, all of which are related to the PestNu project and provide readers with comprehensive updates on its progress (Figure 8).

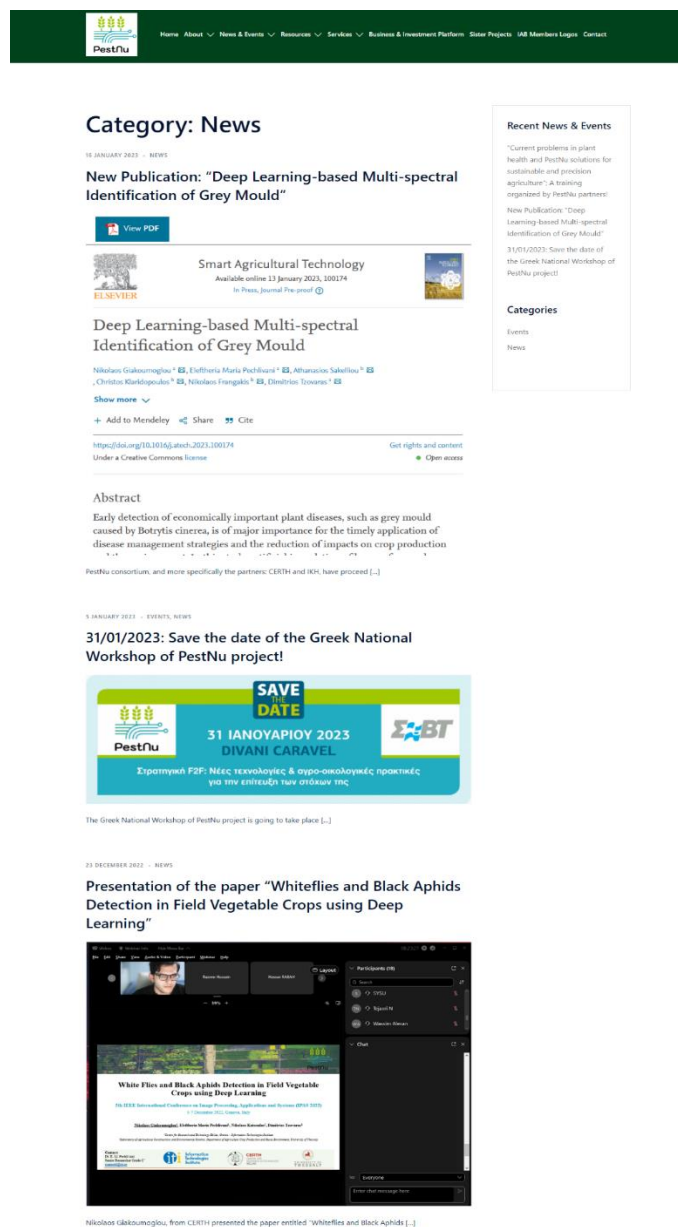


Figure 8: Screenshot of the “News” page of the PestNu digital platform

2.3.3.2. Events

The "*Events*" category (Figure 9) is a vital component of the digital platform, as it provides stakeholders with essential information on all upcoming PestNu project events. This category allows interested parties to attend and participate in events that are relevant to their preferences. Users can register for events via a link that is provided in each blog post, enabling them to attend the event either physically or online, irrespective of their location. The “Events” category includes a range of events, such as national workshops, clustering event workshops, and training events, ensuring that stakeholders can access a diverse range of opportunities to engage with the PestNu project.

Category: Events

14 FEBRUARY 2023 - EVENTS

“Current problems in plant health and PestNu solutions for sustainable and precision agriculture”; A training organized by PestNu partners!

The series of public trainings of PestNu project is continued. An exciting [...]

5 JANUARY 2023 - EVENTS, NEWS

31/01/2023: Save the date of the Greek National Workshop of PestNu project!

The Greek National Workshop of PestNu project is going to take place [...]

14 OCTOBER 2022 - EVENTS

Workshop: “Today’s challenges: Together we secure the future for the Food of our Food”

Dr. Eleftheria-Maria Pechlivani, project coordinator of the Green Deal EU project PestNu. [...]

Figure 9: Screenshot of the “Events” page of the PestNu digital platform

2.3.4. Resources

The "Resources" section comprises two sub-sections, namely "Public Deliverables" and "Downloads." These subsections offer users a convenient means of viewing or downloading communication materials and public deliverables related to the PestNu project.

2.3.4.1. Public Deliverables

The "*Public Deliverables*" section offers users a simple means of browsing PestNu's collection of publicly available deliverables and locating ones that match their specific interests. While this section primarily caters to the scientific community, it may also be of interest to other stakeholders (Figure 10).

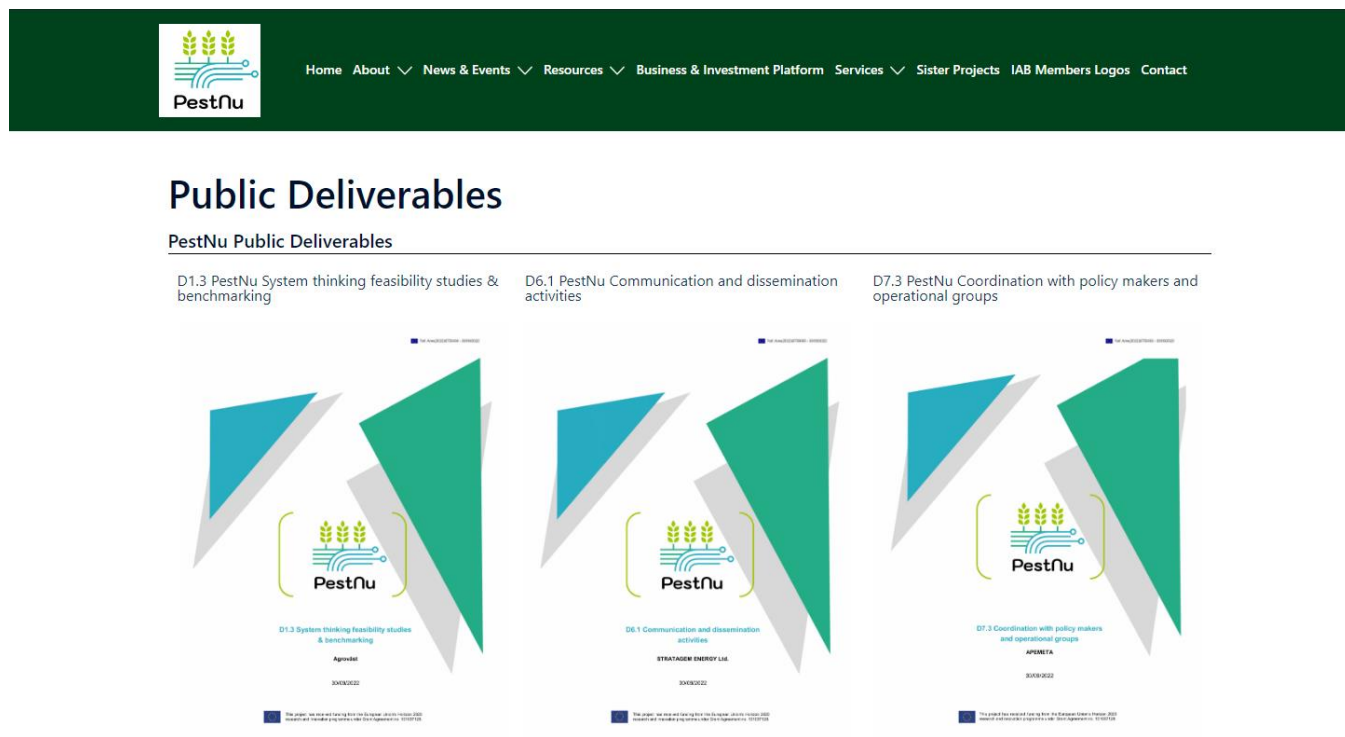


Figure 10: Screenshot of the “Public Deliverables” page of the PestNu digital platform

2.3.4.2. Downloads

Section "*Downloads*" contains the Communication Material for the PestNu project, including the “PestNu Fact Sheets”, “Trifold Brochure”, “PestNu Poster”, and “PestNu Pullup” as seen on Figure 11. These files are typically disseminated during events hosted or attended by the project. This section allows users to conveniently download any of these files, making it a valuable resource for the PestNu’s consortium as well.

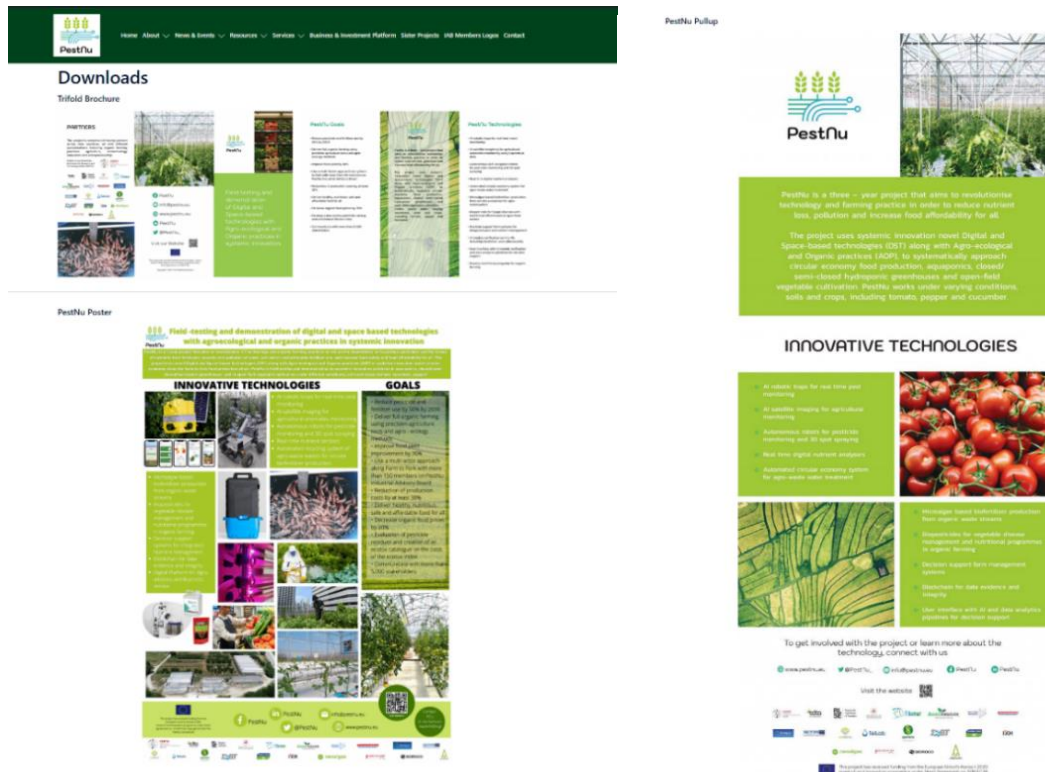


Figure 11: Screenshot of the “Downloads” page of the PestNu digital platform

2.3.5. Services

The “Services” component of the advanced PestNu digital platform for agro-advisory and business services consists of eight subcomponents, which will be analyzed in the next sections (2.3.6.1 - 2.3.6.8). These subcomponents, which encompass "Workshop Results", "Best Practices Materials", "Market Trends", "National Plans", "Training Materials", "Augmented Reality Training Tools", "Online Measurements from Pilot Sites" and "Frequently Asked Questions", provide valuable resources for all PestNu stakeholders, including citizens from farms, practitioners, Non-Governmental Organizations (NGOs), industry, policy makers, SMEs, consumers, researchers, and investors. While some of the services cater more specifically to certain stakeholder groups, every stakeholder can navigate the platform and access useful knowledge and services of interest. By providing a diverse range of resources, the platform seeks to foster innovation and development in the agriculture industry while promoting sustainability and environmental responsibility.

2.3.5.1. Workshop Results

The "*Workshop Results*" service provides a thorough Portable Document Format (PDF) file (Figure 22), which is uploaded to the digital platform and allows attendees to view the outcomes of PestNu's workshops. The PDF includes a detailed analysis of each workshop of the PestNu project, along with all the essential information: photos, agendas, date, location, duration, total number of participants, number of total organizations participated, the main elements of the round table discussions. The information mentioned and presented in the Figure 23, is available for all workshops organized by the PestNu project. The primary purpose of this service is to enable attendees to access useful material

quickly and easily. In addition, stakeholders who were unable to attend the workshops can also use the PDF file to find any necessary information.



Figure 22: Screenshot of the "Workshop Results" page of the PestNu digital platform

The "Workshop Results" service is also valuable for the consortium, as it allows them to gain knowledge from previous workshops and plan their own accordingly. By analysing the audience's main discussion points and concerns, they can gain valuable insights from their partners' workshops and ensure that their events are effective. Moreover, grouping the workshops together in this way ensures that no information is lost, and the workshops maintain a consistent approach. This service also helps platform users to identify relationships between data, providing greater context and meaning to the information presented.



Figure 23 [a], [b], [c], [d], [e], [f]: Screenshots of the Workshop Results PDF

The workshop results consist of a series of slides, each providing valuable information on the event. Figure 23[a] displays fundamental information, including the date, title, and location of the workshop, which are essential details for participants and attendees. The next two figures, numbered Figure 23[b] & Figure 23[c], contain the agendas for each workshop. In Figure 23[b], users can click on each agenda item, which opens a downloadable PDF version of it, that can be accessed online or downloaded for later use. This feature provides users with the flexibility to access and view the agenda in a manner that is most convenient for them. Alternatively, in Figure 23[c], the entire agenda is displayed in a scrolling format, making it easy for users to view the agenda without needing to open a new window or download the file.

Figure 23[d] showcases images promoting physical attendance at the workshops. These images serve to enhance the appeal of the workshop by highlighting the engaging and interactive nature of the event. The images aim to encourage participation, making it clear that the workshop is a unique opportunity to gain valuable insights and connect with relevant stakeholders.

Figure 23[e] provides additional information about the workshop, such as the total number of participants and the number of organizations involved. These details are crucial in demonstrating the high level of attendance and the diverse range of stakeholders present at the workshop. It showcases the significant

interest and engagement from participants, highlighting the relevance and importance of the workshop to the F2F industry.

Finally, the last slides of the PDF file (Figure 23[f]) contain the main elements of the round table discussions that took place during each workshop. These discussions are a vital component of the workshop, as they enable participants to share their concerns and insights, and collaborate on solutions. The round table discussions serve as a valuable opportunity for participants to connect with one another, exchange insights, and work together towards a common goal of knowledge sharing and collaboration.

2.3.5.2. Material on Best Practices

The component “*Material on Best Practices*” (Figure 24) offers a comprehensive set of manuals that provide in-depth guidance on a range of agricultural practices. Specifically designed for farmers and other stakeholders in the agricultural sector, these manuals offer detailed procedures for using various agricultural products to reduce the dependence on hazardous pesticides and reduce the loss of nutrients from fertilisers. The material was created on T6.5 “*Training activities*”, by the PestNu partners.

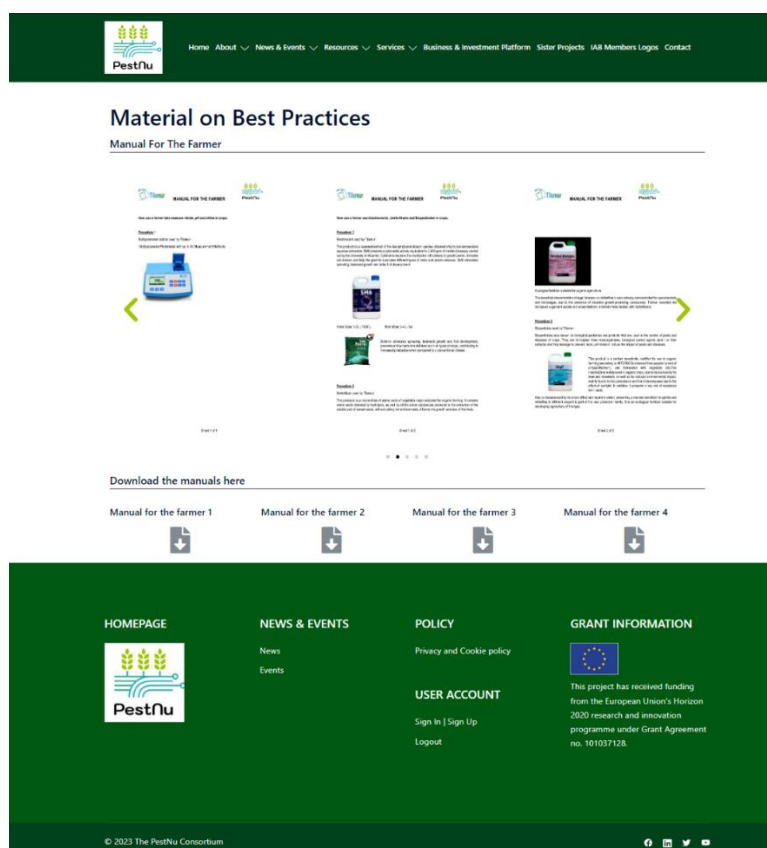


Figure 24: Screenshot of the “Material of Best Practices” page of the PestNu digital platform

The manuals cover a broad range of topics, from simple manual traps for controlling pests in crops (Figure 25[a]), to more advanced procedures for measuring nitrate, pH, and nitrite levels in crops (Figure 25[b]). Additionally, the manuals provide guidance on using biostimulants, biofertilizers, and biopesticides (Figure 25[d] & Figure 25[e]) to promote sustainable and organic farming practices. Furthermore, the manuals offer practical guidance on how to use robots in agriculture (Figure 25[c]), including how to integrate them into a farming operation.

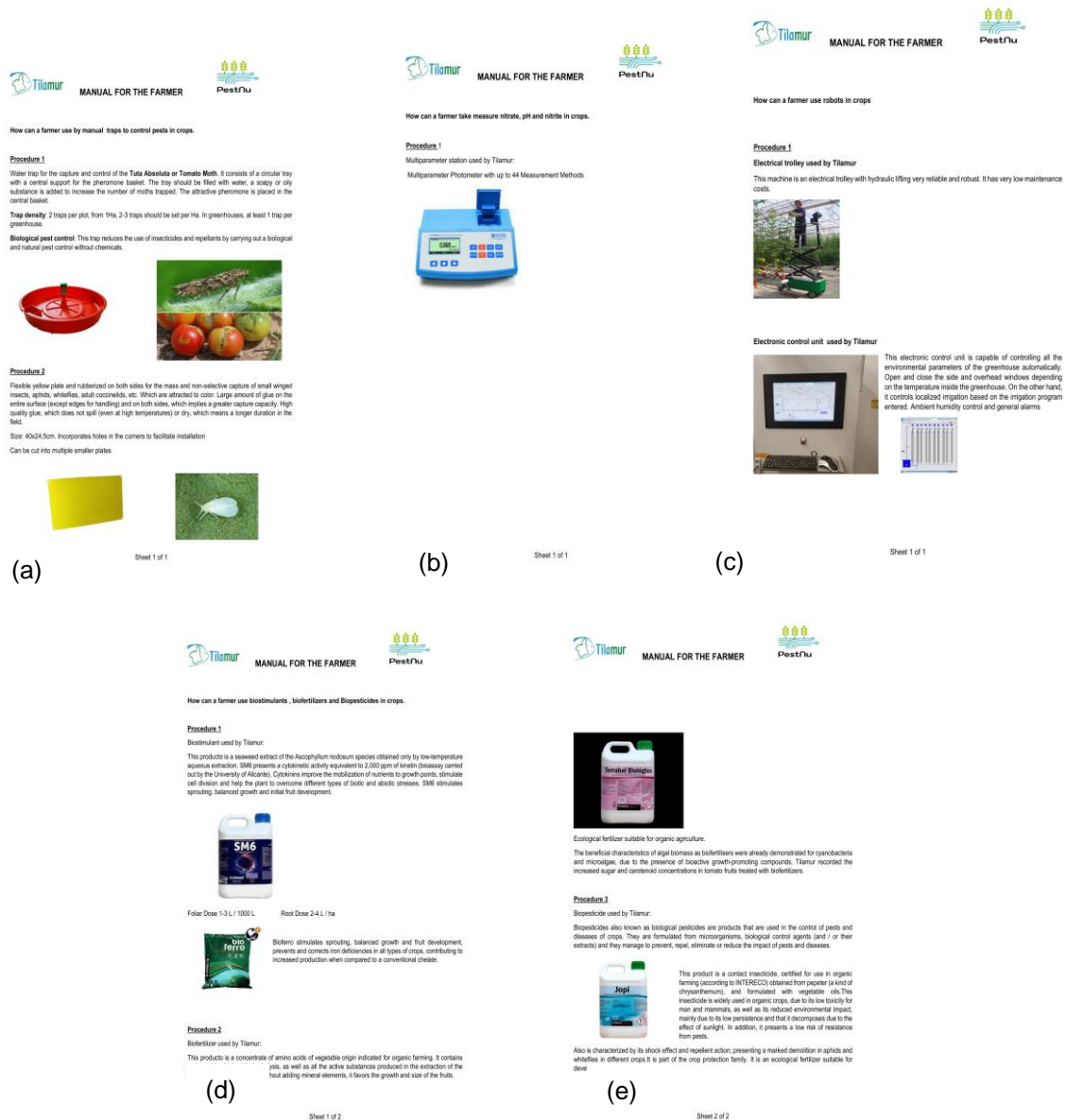


Figure 25 [a], [b], [c], [d], [e]: Screenshots of the Manual for the Farmer PDF

The manuals are a precious asset for any farmer looking to take a step further in precision farming, as they provide relevant detailed instructions that are easy to follow. Farmers who wish to use organic products and precision farming tools can benefit significantly from the guidance offered in the manuals.

To ensure that the manuals are easily accessible to all users, they are available in two different formats. The first format is a photo-carousel, which is ideal for digital platform visitors who want quick and easy access to the manuals. The second format is a downloadable PDF that can be accessed and saved offline, allowing users to view and print the manuals at their convenience. The availability of the manuals in these two formats provides a user-friendly experience for all types of users, regardless of their preference for accessing the manuals.

2.3.5.3. Market Trends

The “*Market Trends*” component is a highly significant and relevant component, encompassing a diverse range of forecasts related to various PestNu thematics such as aquaponics, pesticides, fertilizers, biopesticides, biofertilizers, agriculture sensors, agriculture IoT, artificial intelligence in agriculture, agricultural robot, and 3D printing (Figure 26).



Figure 26: Screenshot of the “Market Trends” page of the PestNu digital platform

Each of these categories contains a minimum of three forecasts that have been meticulously selected after an extensive research process. These forecasts have been identified as the most pertinent to the PestNu stakeholders. As users navigate through this section, they will find that they can dive deeper into their preferred thematic and follow the links that are most relevant to their interests to explore further analysis. It is important to note that the forecasts within each category have been carefully evaluated to provide an accurate representation of the market trends. As such, this section serves as an invaluable

resource to anyone seeking to stay informed on the developments and advancements among the PestNu related industries.

2.3.5.4. National Plans

The service named "*National Plans*" provides a valuable resource that enables users to access the most recent and relevant national plans from authorised platforms and websites of each PestNu consortium country. These plans are focused on critical themes that cover various aspects of agriculture and agri-food, such as the use of pesticides and fertilisers, regulations, protocols, and standards that are applicable at national, EU, and global levels.

The national plans of each of the 9 countries within the PestNu consortium, namely Austria, Cyprus, Greece, Ireland, Italy, Portugal, Spain, Sweden, and the UK, are clearly presented in Figure 27. Each of the PestNu partners will update their respective country's national plan, ensuring that the information remains current and up-to-date. This service provides an excellent opportunity for users to quickly and easily navigate through each plan, gaining a deeper understanding of the regulatory environment that pertains to each country. By utilizing this service, stakeholders in the agriculture and agri-food industry can remain up-to-date on the most recent national plans and regulations that impact their work, enabling them to make more informed decisions that ultimately benefit both the industry and the wider public.

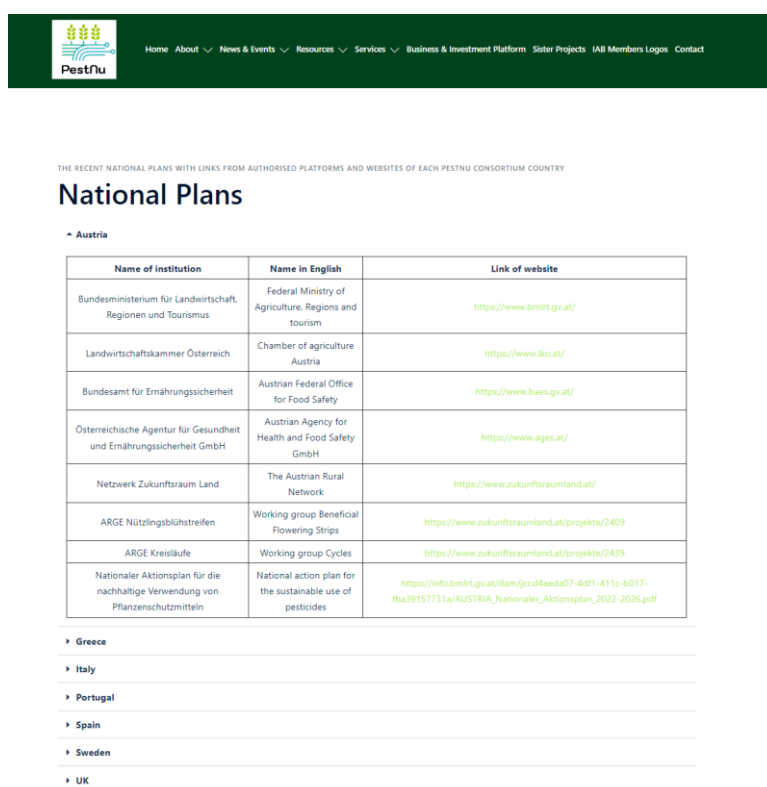


Figure 27: Screenshot of the “National Plans” page of the PestNu digital platform

In addition to the comprehensive coverage of national plans in the agriculture and agri-food sector, the website also features a user-friendly interface that allows users to easily access and navigate through the content. Specifically, the national plans are developed with country classification, enabling users to toggle between countries and open the national plan that is relevant to their country. This feature ensures that users can quickly locate the information they need without having to sift through irrelevant content.

2.3.5.5. Training Material

The “*Training Material*” service provides a diverse range of resources for PestNu stakeholders, including presentations, videos, and PDF files (Figure 28). These materials are gathered from the educational programmes offered by T6.5 Training activities and showcase the tools used in the PestNu project. A variety of videos are available, showcasing PestNu tools such as the SpyFly, an AI robotic trap for real-time pest monitoring, and the SiVi tool dashboard, a human-interactive and visually oriented detection system for anomalies. Additionally, there are videos demonstrating how to use the Aquamonitrix Nitrate/Nitrite analyzer, including how to refill the eluent and dispose of waste, as well as more presentations on topics such as aquaponics, circular economy, and Microalgae.

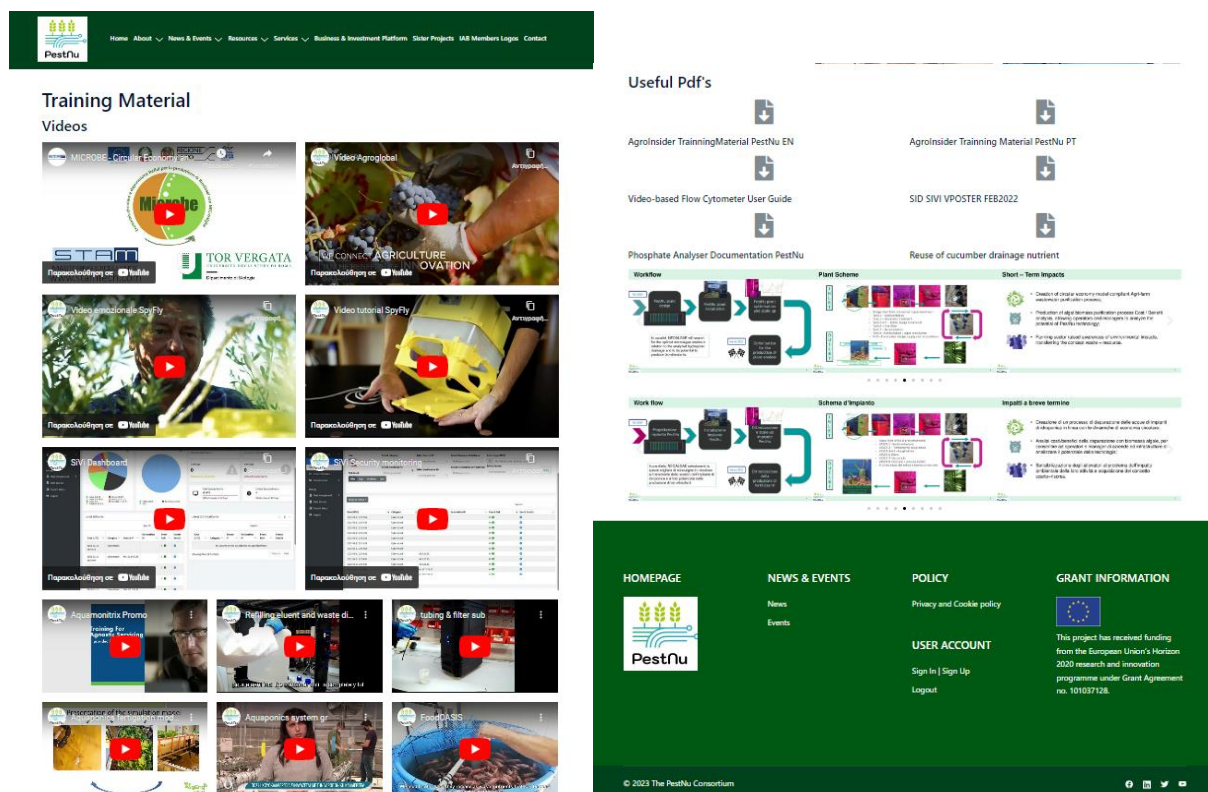


Figure 28: Screenshots of the “Training Material” page of the PestNu digital platform

Numerous PDF files are available on the service, including not only tool presentations but also user guides on how to use them, such as the User Guide for the Flow Cytometer, for detection of E. coli in drinking water based on specific fluorescent labelling of bacteria followed by video camera-based detection, and the Phosphate and Ammonium Analyzer Documentation. This service is incredibly useful for training PestNu stakeholders on how to use the tools offered by the PestNu project. Finally, PowerPoint presentations for Projects’ visualization with easy-to-follow charts and graphs have been uploaded. In addition to the current available training materials, it is worth noting that the PestNu project will have training material available in all consortium languages, including Greek, English, Spanish, Italian, Portuguese, Swedish, and German. This effort will ensure that all PestNu stakeholders have access to the training material in their preferred language, facilitating a better understanding and adoption of the project's tools and technologies.

2.3.5.6. Online Measurement from Pilot Sites

The “Online Measurement from Pilot Sites” service is designed to provide real-time visualization of results and measurements obtained from the Decision Support System (DSS) at the pre-pilot and the two demo sites that are at UTH, Tilamur, and CDTA respectively. The service is easily accessible to visitors of the digital platform through a user-friendly interface. The results and measurements will be uploaded and presented on the M19 of the PestNu project once the demo sites start.

In terms of data, the data that are generated from the DST and the data that are produced by the analytics component in the DSS, will be collected and stored in a database. This data will then be made available through a REST API that is currently under development. This will allow the digital platform to retrieve the necessary data by making HTTP GET requests to the appropriate endpoints that are exposed through the aforementioned REST API.

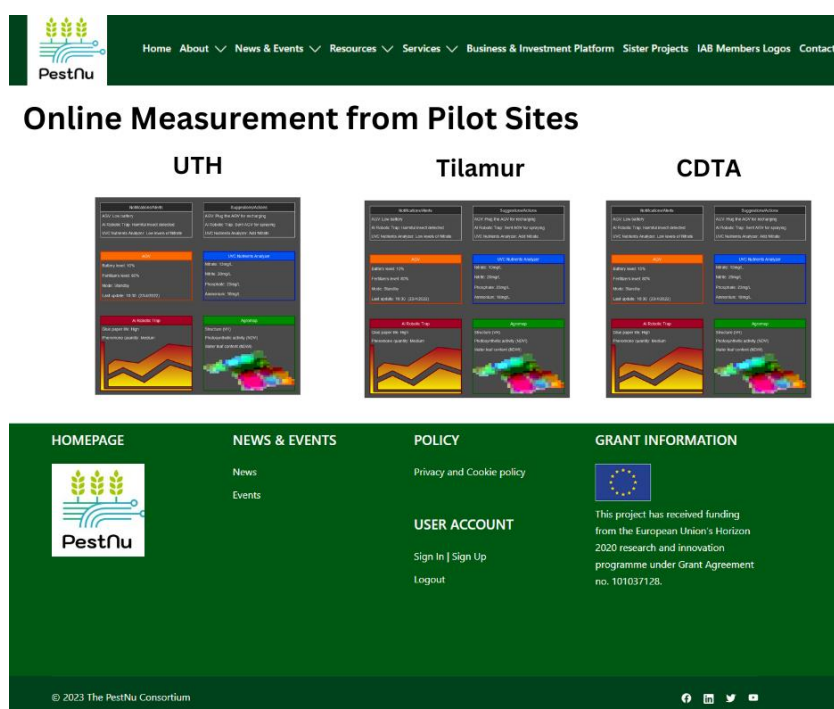


Figure 33: Mock-up of “Online Measurement from Pilot Sites” page of the PestNu digital platform

The “Online Measurement from Pilot Sites” prototype (Figure 33) presents all three pilots and includes measurements for each of them. These measurements will comprise data collected by the tools utilized in WP2: Automated Guided Vehicle (AGV), Ultraviolet C (UVC) Nutrients Analyzer, AI Robotic Trap, and Agromap.

2.3.5.7. Frequently Asked Questions (F.A.Q.)

The “*F.A.Q.*” component is an essential component for every digital platform as it provides a user-friendly interface for presenting commonly asked questions and their answers. The questions and answers included in this component were collaboratively created by the entire consortium, taking into account the varied specializations and experiences of each partner to ensure that all stakeholders in the PestNu project were considered.

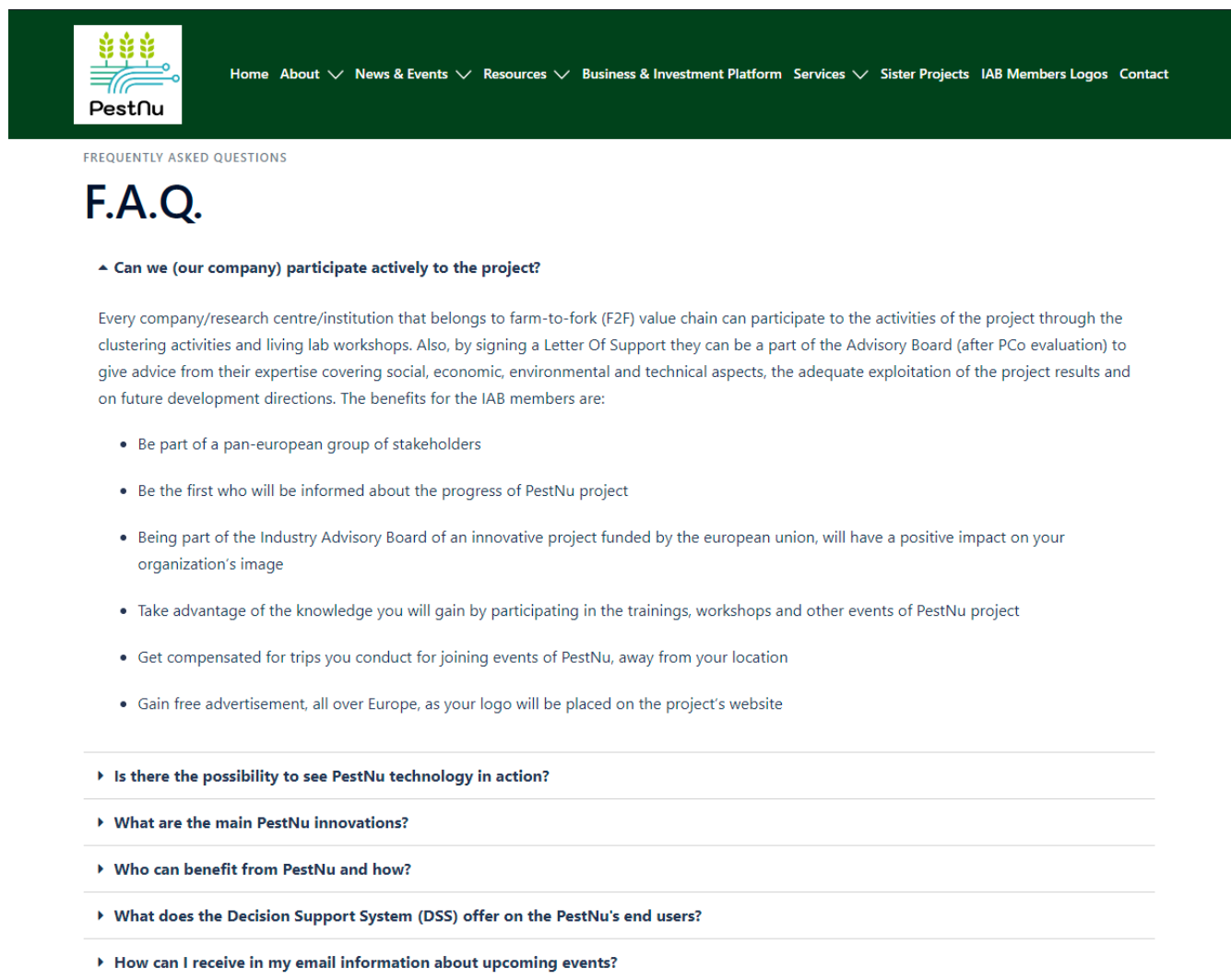


Figure 34: Screenshot of the "F.A.Q." page of the PestNu digital platform

To easily find answers, the user can toggle the question to reveal the answer, allowing them to quickly access the information they need. The F.A.Q. component includes both general questions, such as "Can we (our company) participate actively in the project?" and "What are the main PestNu innovations?" as well as more specific ones, such as "What does the Decision Support System (DSS) offer on the PestNu's end users?" or "Is there the possibility to see PestNu technology in action?". The F.A.Q. component is a crucial resource for providing clear and concise information to users of the digital platform, and it will help ensure a positive user experience.

2.3.6. Sister Projects

The "*Sister Projects*" page (Figure 35) is a crucial component of the platform, as it ensures seamless connectivity with the websites of related projects. The page is designed with user-friendliness in mind, allowing users to effortlessly access sister project websites by clicking on their respective logos. By redirecting the user to a new tab, they can stay engaged with the digital platform while exploring related projects, making it easier for them to return to the PestNu platform and explore its services more extensively.



Figure 35: Screenshot of the “Sister Projects” page of the PestNu platform

2.3.7. IAB Members Logos

The PestNu project offers interested parties the opportunity to become part of its Industry Advisory Board by signing a Letter of Support and undergoing evaluation by the project coordinator. IAB members provide advice from their areas of expertise, which cover a broad range of topics such as social, economic, environmental, and technical aspects. They also offer guidance on the proper exploitation of project results. With an impressive amount of 123 members, the PestNu IAB consists of experts from various countries, each possessing a unique set of skills and knowledge. To highlight their presence, the logos of the IAB members are uploaded on the PestNu digital platform (Figure 36) in the page titled “*IAB Members Logos*”.



Figure 36: Screenshot of the “IAB Members Logos” page of the PestNu platform

2.3.8. Contact

It is essential for the digital platform to provide users with the means to communicate further with the project, should they have any questions or wish to develop synergies with the PestNu project. This is precisely why the Contact page is crucial, and why there is a redirection button from the homepage of the platform to the Contact page.

The “*Contact*” page (Figure 37) is designed to provide users with two options for getting in touch: they can either find the Project Coordinator’s contact information or use the contact form to send a message directly to the PestNu team. The page has been structured in this particular way with the aim of making it as easy as possible for users to communicate and develop synergies with the project.

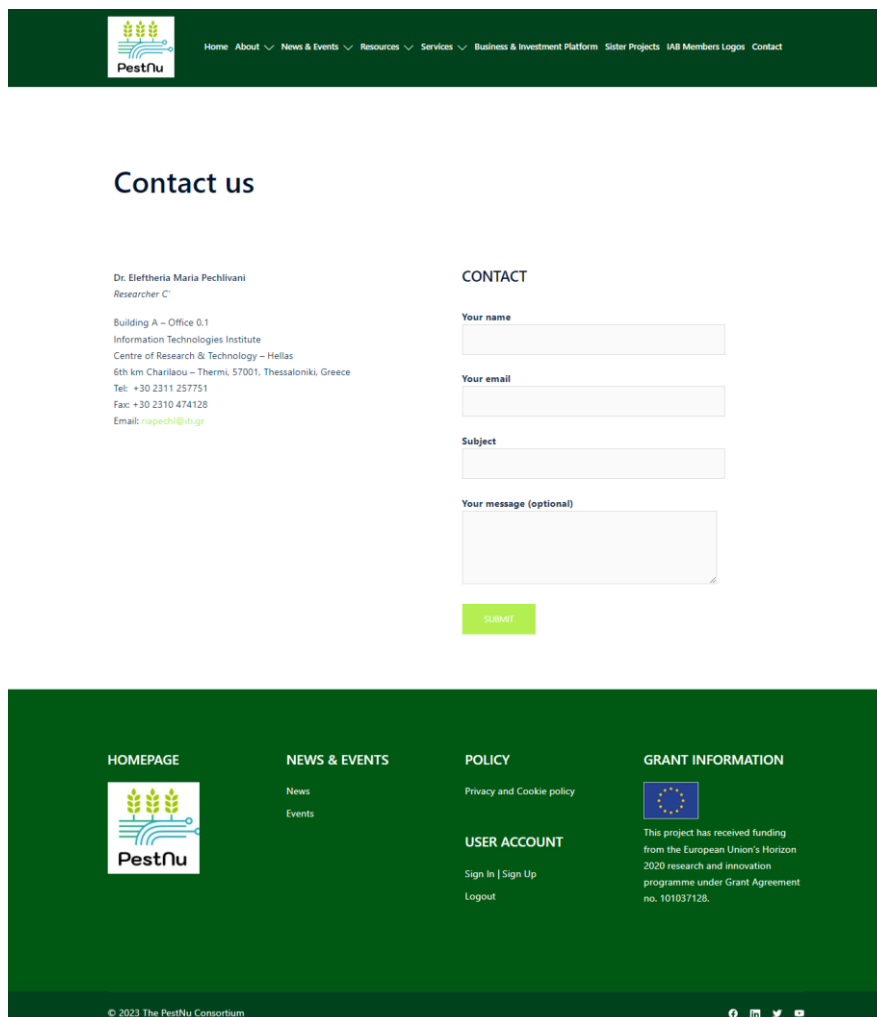


Figure 37: Screenshot of the “Contact” page of the PestNu platform

3. Digital Platform for Agro-advisory and Business

3.1. Business & Investment Opportunities Tool

PestNu offers to the F2F stakeholders a robust matchmaking tool, "*The Business & Investment Opportunities toolkit*" (<http://pestnu.itigr>). This tool represents a significant leap forward in terms of functionality and utility within PestNu digital platform. This service is particularly noteworthy for its potential impact on agriculture considering the creation of networks, partnerships, Business-to-Business (B2B) / Business-to-Consumer (B2C) collaborations and investments. By registering to the tool and exploring its features, users can discover exciting new opportunities to build partnerships and synergies with like-minded professionals, look for specific capabilities, skills and profiles and link directly to the relevant profile. Thanks to the matchmaking tool, finding the right collaborators has never been easier. Whether users are seeking specific types of collaborations or simply looking to network with others in the agriculture industry, the tool's user-friendly interface makes it simple to find and connect with potential partners with the preferred profile on services/technologies and farms ownership. Whether searching for new talent, exploring innovative ideas, or simply looking to expand their professional network, users can easily leverage this powerful tool to achieve their goals.

One of the key benefits of the Business & Investment Opportunities tool is its simplicity. Unlike other complex and confusing platforms, this tool has been designed with a user-friendly interface that makes it easy to navigate and use, even for those with little or no prior experience. Essential buttons and filters are prominently displayed, ensuring that users can quickly and easily find what they need without getting bogged down in unnecessary details. In short, the Business & Investment Opportunities tool is an essential resource for anyone involved in the F2F chain. By providing a simple yet powerful platform for collaboration, PestNu is empowering professionals in the agriculture industry to achieve new levels of success and innovation.

The tool features an authentication process that allows only registered users to proceed to the homepage. Once a user has registered for the Business & Investment Opportunities Tool, they can explore the homepage, which displays all registered users. The user can proceed on five levels on the matchmaking process, each one based on the fields they completed during registration. This ensures that users are matched with potential business partners or investors that align with their specific requirements and interests. Upon finding a suitable match, the user can view the matching user's profile and engage in a chat session to further discuss potential business opportunities. Additionally, users have the option to create posts on their own profiles highlighting their interests and expertise, to attract potential partners or investors to engage in conversation within a chat box.

3.1.1. Architecture

The technology architecture used for the development of the "Business and Investment Opportunities" component is the MERN stack (Figure 12). The MERN stack is a collection of technologies used for developing web applications, consisting of MongoDB, Express.js, React.js, and Node.js. It allows for full-stack JavaScript development, making it a popular and efficient technology stack for modern web application development. The MERN stack provides scalability, flexibility, and fast development capabilities, making it an ideal choice for a wide range of web applications, from simple single-page

apps to complex, data-intensive applications. With its well-documented components and active developer community, the MERN stack is a reliable and widely used technology for web application development.

The MERN stack is a well-suited technology for developing the "Business and Investment Opportunities" component of the PestNu Digital Platform for several reasons. Firstly, the use of JavaScript for both front-end and back-end development streamlines the development process, enabling developers to work efficiently and effectively. Additionally, the components of the MERN stack are widely used, well-documented, and have large communities of developers who can provide support and guidance. Furthermore, the scalability and flexibility of the MERN stack make it ideal for developing complex and data-intensive applications, which is necessary for a feature like "Business and Investment Opportunities" that requires robust data handling capabilities. Finally, the ability to automate the process of building, testing, and deploying the application using the MERN stack allows for rapid iteration and improvement, which is crucial in a rapidly evolving business environment.

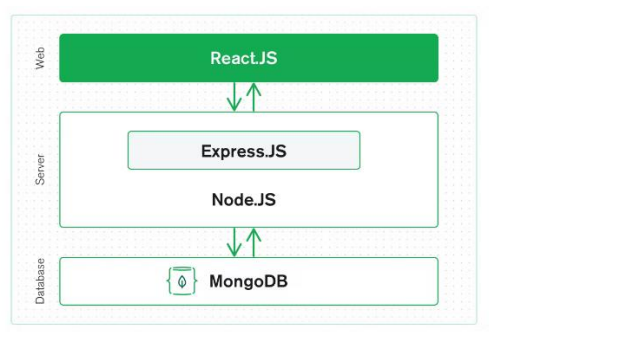


Figure 12: MERN Stack¹

The application's architecture, as illustrated in Figure 13, comprises three significant components: the "Matchmaking" component, the "User profile" component, and the "Chat" component. Each of these components will be thoroughly analysed later. However, before delving into their details, it is worth noting that the application is safeguarded by a robust user authentication system, since it prevents unauthorized access, and unregistered users are not able to access the tool.

¹ MongoDB, <https://www.mongodb.com/mern-stack>

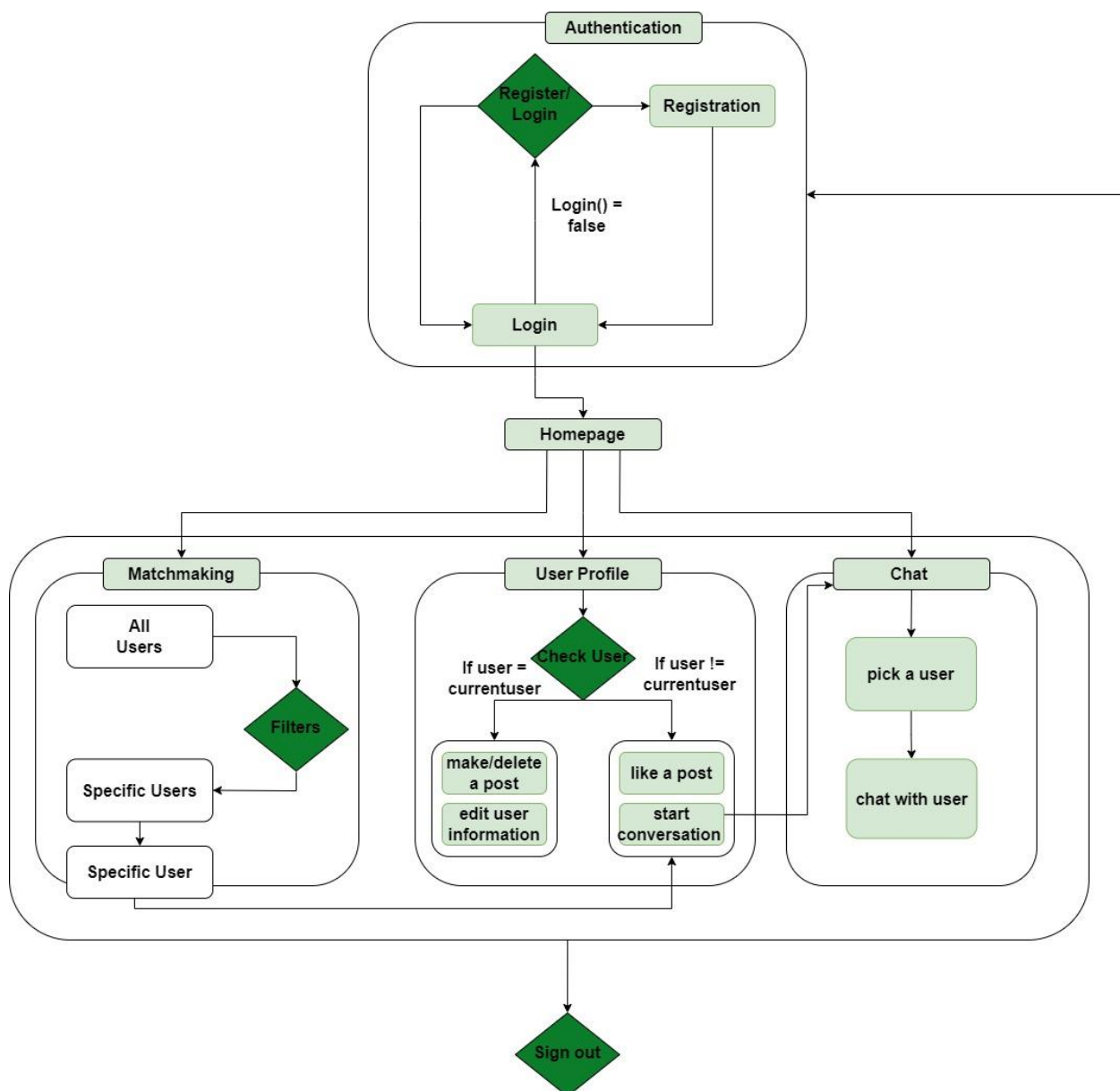


Figure 13: Business and Investment Opportunities Tool Architecture View

3.1.2. Database

The PestNu platform’s tool, Business & Investment Opportunities Tool, is made up of various components and functionalities. In order to integrate these tools, it was necessary to design and implement a common database schema. The purpose of this schema was to store essential data in the most efficient and effective way possible. The database schema, is developed on MongoDB and consists of four collections, which are essentially equivalent to tables in a traditional relational database. Each collection contains rows, which are individual documents or records within the collection. These rows have specific characteristics, which can be thought of as columns in a traditional table. However, in MongoDB, the rows are actually JSON documents that can have a flexible structure and contain nested fields.

In the Business & Investment Opportunities Tool database, there are four main collections: users, posts, conversations, and messages, as shown in Figure 14. The users collection contains all the information that users provide on the registration form (see more on 2.3.5.3.1), including their username, email, hashed password - using the bcrypt protocol, which is a secure method for storing passwords -, profile picture, participation, country, organization, area, collaboration and a unique `_id` is given to each user, that will be further used in the other collections. The posts collection includes `_id`, `userId` (the same as the `_id` on the users' collection), `desc`, `img`, and `likes`. The conversations collection includes `_id` and a `members` array that contains the `_id` of the two users. Finally, the messages collection includes `_id`, `conversationId` (which is the same as the `_id` in conversations), `sender`, and `text`. All of these fields are text, except for `members`, which is an array.

Therefore, the database schema for the PestNu platform and specifically for the Business & Investment Opportunities Tool, was designed to facilitate the integration of different tools and functionalities, and to ensure that the data is stored in a way that is optimized for the specific requirements of each tool.

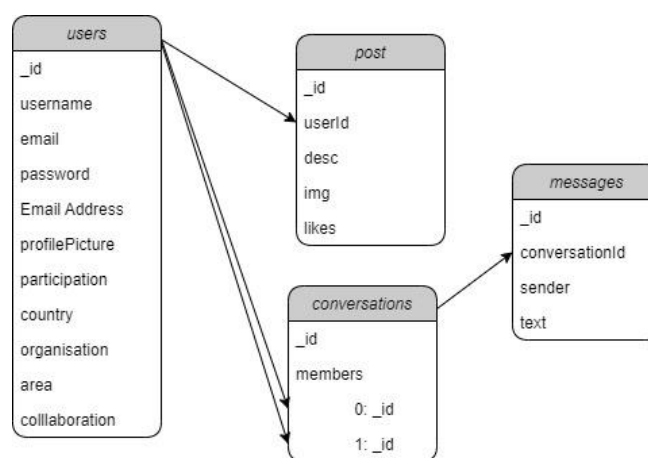


Figure 14: Business & Investment Opportunities Database Schema

3.1.3. Authentication

Unauthenticated users are strictly forbidden from accessing any of the components and are promptly redirected to the registration or login page. Additionally, if a user attempts to log in with incorrect credentials, they are also redirected to the registration or login page. This multi-layered authentication process ensures that only authorized users can access the app's functionalities, guaranteeing maximum security and user privacy. The authentication process followed by the app is a registration or login procedure, depending on whether the user is new to the platform or has previously registered.

3.1.3.1. Registration

The registration form comprises carefully selected fields that are crucial in enabling the matchmaking process to deliver the most accurate results possible. The fields included in the registration form were chosen after extensive research and consultation with all the consortium parties involved. These parties, leveraging their expertise and considering the needs of their respective end-users, agreed on the specific fields to be included in the registration form. Therefore, after taking into account the F2F community the registration form was finalized, as depicted in Figure 15.

The image shows a 'Registration Filters' interface with a green header. It contains five filter panels:

- Participation Type:** Farmer, Company expert of the pesticides, fertilisers, Agriculture, cooperatives, agrofood associations, clusters, Precision Agriculture Manufacturing, NGO, enviromental, agriculture, agrofood, University, Research Center, Food Grocery & Supermarket Retailers, Agronomist, Other.
- Organisation:** R&D Institution, Company/SME, Start-up, Cluster, DIH, Competence Center, Company/Industry, Authority/Goverement, Association/Agency, Investor, Farm, Other.
- Country:** All countries.
- Area:** Precision Agriculture, Robotics, Sensors, Decision Support Systems, Drones, Smart Phone Applications, Satellites, GNSS, Pesticides, Fertilisers, Other.
- Provide collaboration on:** Digital Technologies, Agroecological Products, Organic Farming, Other.

Figure 15: Business & Investment Opportunities Tool Registration Filters

By incorporating only the most relevant fields in the registration form (Figure 16), the app ensures that the matchmaking process is optimized to deliver personalized recommendations that align with the user's preferences and requirements. This enhances the user experience and helps to foster long-term user engagement with the app.

The image shows the 'REGISTER' page of the PestNu app. On the left is the PestNu logo and tagline: 'Connect with PestNu's stakeholders all around the world.' On the right is a registration form with the following fields:

- Username
- Email
- Password
- Password Again
- Participation Type (dropdown menu)
- Country (dropdown menu)
- Organisation (dropdown menu)
- Area (dropdown menu)
- Provide collaboration on (dropdown menu)

At the bottom of the form are two buttons: 'Sign Up' and 'Log into Account'.

Figure 16: Register Page of Business & Investment Opportunities Tool

New users are required to fill in their information and complete the registration process in order to access the tool. Once the registration is complete, the user will be automatically redirected to the Login page, where they can securely log in and gain access to the full range of features and functionalities.

3.1.3.2. Login

The login page (Figure 17) has been designed to be as simple and user-friendly as possible, in keeping with the platform's overarching theme of simplicity. Users are only required to input their email address and password, which they have previously registered during the sign-up process, to gain access to the platform.

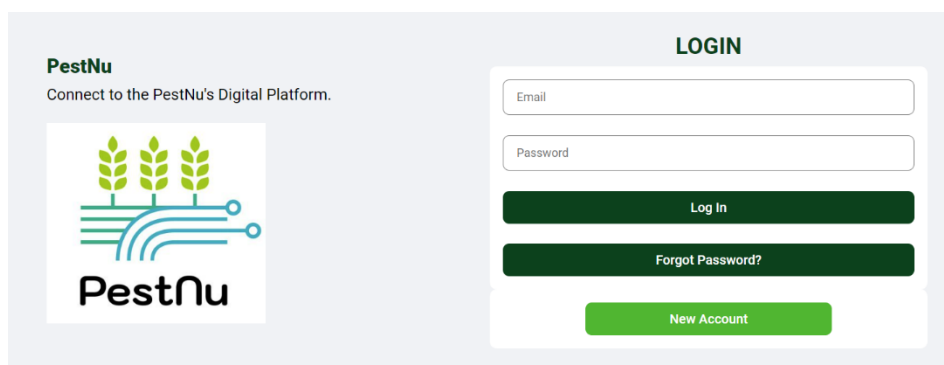


Figure 17: Login Page of Business & Investment Opportunities Tool

3.1.3.3. Forgot Password

For users who have forgotten their password, they can easily reset it by entering their registered email address. To initiate the password reset process, the user needs to click on the "forgot password" button on the login page (Figure 17). They will then be redirected to a new page where they can enter their email address. After submitting the email address, an email will be sent to the user with instructions on how to reset their password. The user can follow these instructions to create a new password. Once the new password is set, another email from PestNu platform will be sent to confirm the successful password change. The user can then log in to the Business and Investment Opportunities Tool using their new password.

3.1.4. Tool's Components

Once the user has successfully completed the authentication process, he/she will have access to the full range of functionalities offered by the tool. The tool is comprised of three main components, each with a distinct purpose and set of features. These include the "Matchmaking tool", which serves as the homepage and allows users to connect with potential matches based on shared interests and preferences. The "User Profile" section which provides users with the ability to create and manage their personal profile, showcasing their unique qualities and characteristics, or to check other users' profiles. Finally, the "Chat" feature enables users to engage in real-time conversations with other users and explore potential connections in a private and secure setting. These three components will be further analysed later on, to provide a deeper understanding of the platform's capabilities.

3.1.4.1. Matchmaking

The "Matchmaking" component is the centerpiece of our business and investment tool, serving as the tool's homepage. Its significance cannot be overstated, as it facilitates the creation of numerous business opportunities. By using specific filters, all stakeholders in the F2F supply chain can easily find exactly what they are seeking. This feature is especially critical as users with similar interests can

connect with each other and engage in further communication regarding investment and business prospects. On the homepage, registered users are presented with basic information, including their username, participation type, and profile picture, if uploaded, this detail is not mandatory. The matchmaking process has five levels, with users being able to use any or all of them depending on their specific needs. The level of specificity determines the filters used in the process, with more levels allowing users to narrow their search for more precise results. The combination of filters available to users is extensive, giving them the ability to find the perfect match for their investment or business goals.

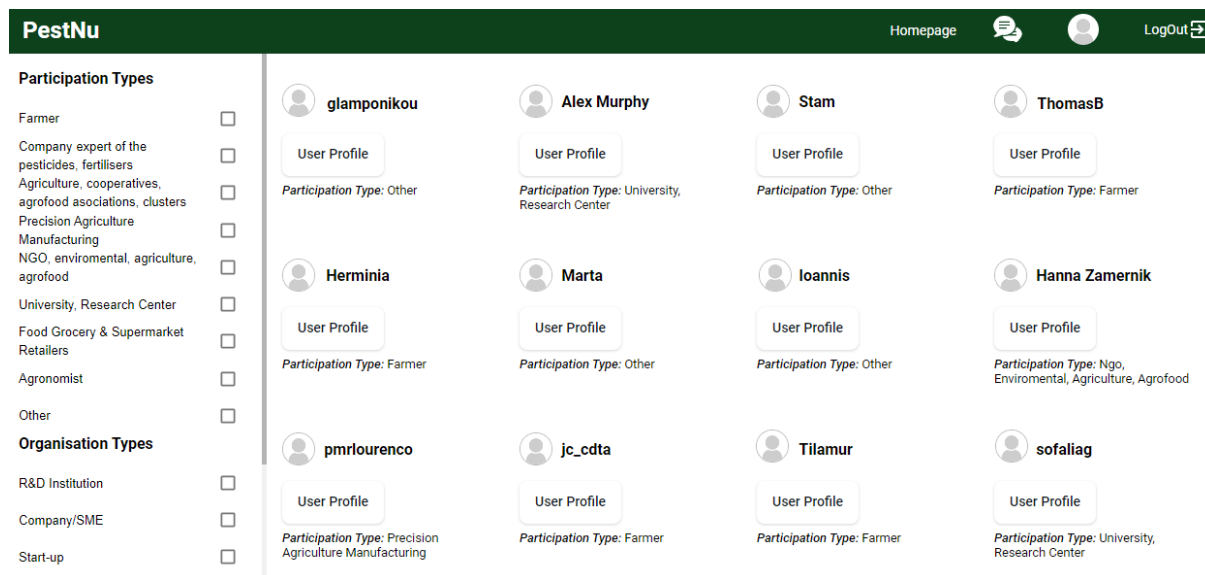


Figure 18: Homepage of Business & Investment Opportunities Tool

The homepage (Figure 18) is divided into two sections. The first section contains all the filters for the five levels of the matchmaking process, which are the same, as the registration filters, as seen on Figure 15, while the second section displays a list of all registered users. Users can select some or all of the filters that work best for them, and the second half of the screen will then show all the registered users who meet the selected criteria. This allows the homepage to display a list of suggested users for the current user, based on the results of the matchmaking process.

3.1.4.2. User Profile

The “User Profile” is a crucial component of the Business & Investment Opportunities Tool and has two different versions depending on whether the current user is viewing their own profile or someone else's, as shown in Figure 13. In both versions, the page's structure is similar: the user's profile image is displayed along with any posts they have uploaded, such as significant works or a mini-Curriculum Vitae (CV) to attract other users. The right column of the page displays the user's information from the registration process.

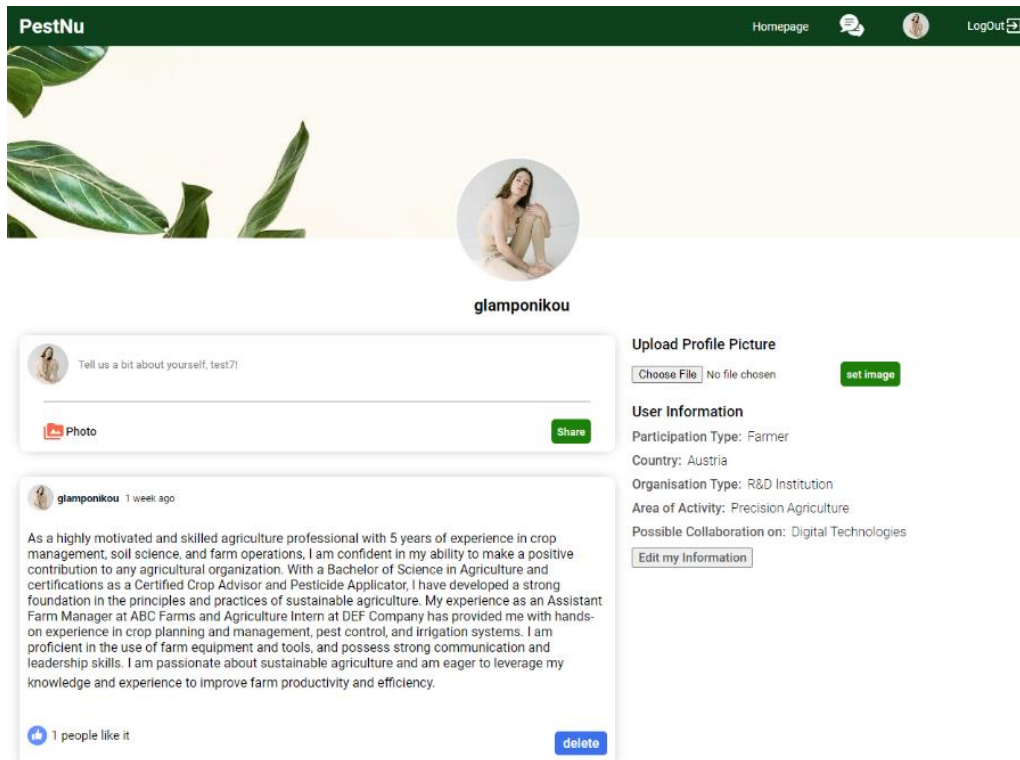


Figure 19: Current User Profile

If the users are viewing their own profile (Figure 19), they can upload posts and images, delete their own posts, and update their personal information in the right column. They can also change their profile image at any time by clicking the "Choose File" button in the "Upload Profile Picture" section. If the users are viewing someone else's profile (Figure 20), they can like the other user's posts or click the "Start Conversation" button to initiate a chat with that user and be redirected to the chat page.

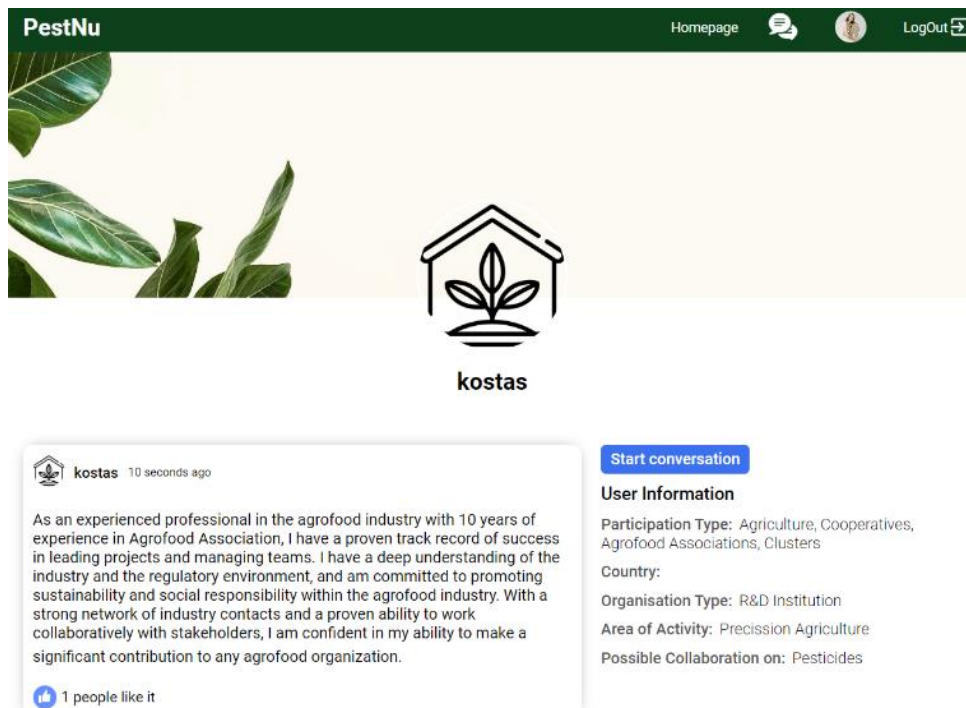


Figure 20: User Profile

3.1.4.3. Chat

The “Chat” feature becomes available after the user has gone through the matchmaking process, navigated to a user profile, and decided to initiate a conversation for business purposes. The chat screen is divided into two sections. The first one displays all the other users the user has previously conversed with. Clicking on the "Start Conversation" button adds a new user to the list by sending a post request to the backend. Once a conversation is created, both users can chat with each other in real-time, as shown in Figure 21, which displays the perspectives of both users.

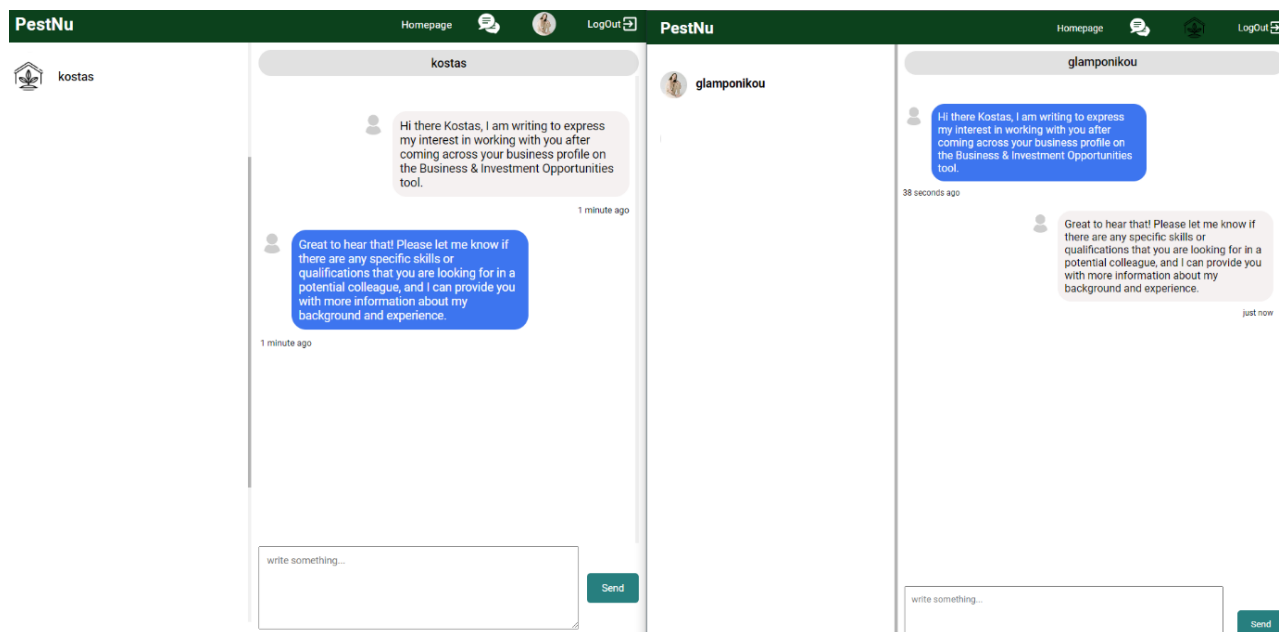


Figure 21: Chat component, chat with two users

3.2. Augmented Reality (AR) Training Tool

The “*AR Training Tool*” service, developed by CERTH in the iPRODUCE H2020 project, has been adapted to support e-Agriculture training. This service offers a more dynamic alternative to traditional training methods and includes a training program that engages PestNu's end-users. One of the specific procedures already available is the “3 Dimensions (3D) Printing of agri components and parts” which is a creative way to apply 3D printing in the agriculture industry. This procedure allows farmers or any citizen interested in farming to learn 3D printing for any component or part they want to print.

Farmers can use 3D printing to make customized parts for their farming equipment, which can be expensive and difficult to replace. This can be especially useful for outdated machinery, where parts may not be readily available. With 3D printing, farmers can easily print replacement parts using affordable filaments such as Polylactic Acid (PLA) and Acrylonitrile Butadiene Styrene (ABS) thermoplastics, which are easy to print and readily available in the market. This enhances productivity and enables farmers to deal with situations such as a broken component without disrupting the production process.

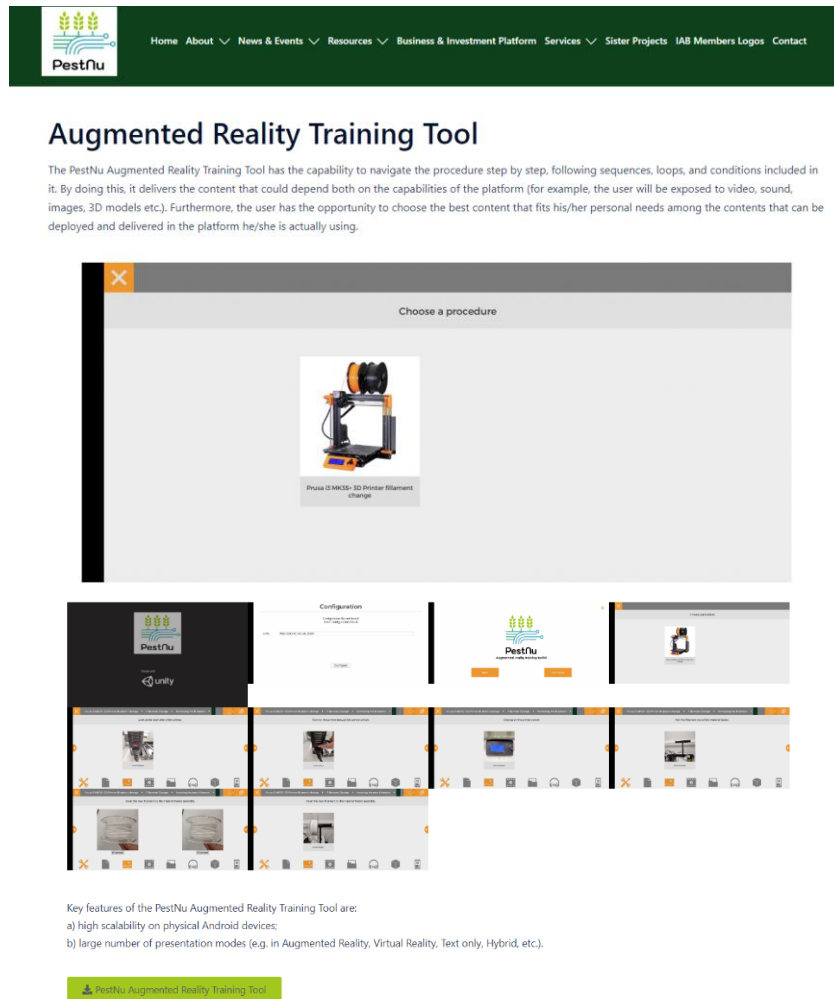


Figure 29: Screenshot of the “Augmented Reality Training Tool” page of the PestNu digital platform

The service “AR Training Tool” (Figure 29) contains screenshots of the app that include helpful information for users such as the required IP address for configuration and also screenshots of the steps of a procedure called “3D Printing of agro components and parts”. Users can also download the PestNu Augmented Reality Training Tool app instantly in the form of an .apk file. To install it on an Android device, the user can simply click on the corresponding button (Figure 29). After the installation is complete, the user will need to log in to the application using the credentials provided on the "Augmented Reality Training Tool" page and perform the necessary configurations. Figure 30 displays the tool's initial interface.

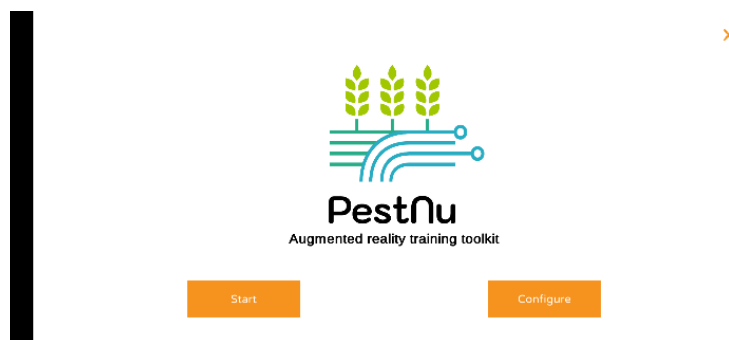


Figure 30: Augmented Reality Training Tool

Upon launching the application, the user gains access to enrolled training procedures, which can be viewed and downloaded. As shown in Figure 31, one such procedure is called "Prusa i3 MK3S+ 3D Printer filament change." Once the user has selected a desired training procedure, the application downloads it to their Android device. This enables the user to browse through the individual training steps and view any associated media content.

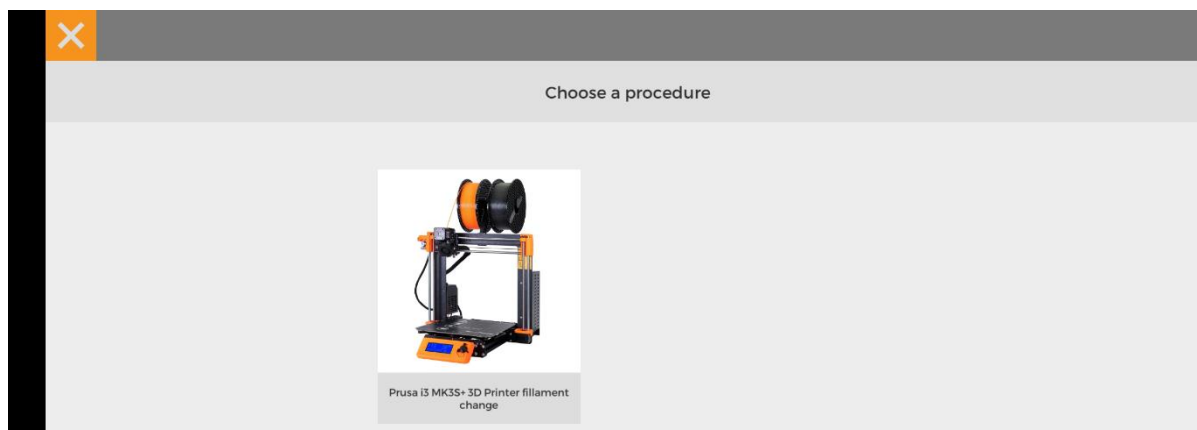


Figure 31: Training Procedure on Augmented Reality Training Tool

The application offers a unique feature that allows the user to utilize their Android device's camera to project a 3D model (AR) into their surrounding environment. Through the animation of the 3D model, the user can gain an interactive understanding of the training procedure. An example of this can be seen in Figure 32, which illustrates a step of the training procedure. The bar with the images below shows the available content of this step (the images are highlighted with the orange color).

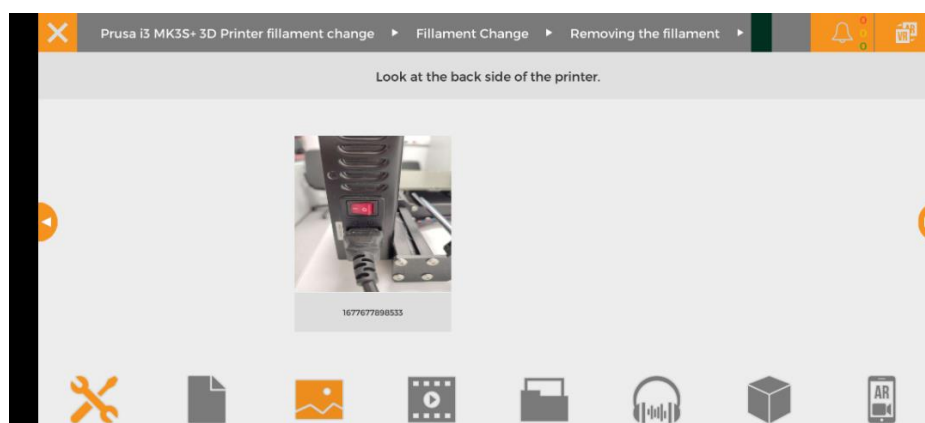


Figure 32: A step of the training procedure of the Augmented Reality Training Tool

The bar contents from left to right are:

- Text description
- Document files (.pdf, .doc, .docx, .txt, .srv)
- Image (.jpg, .jpeg, .bmp, .png)
- Video (.MPEG, .mp4, .3gp)
- Files
- Audio (.mp3, .wav)
- 3D Models (.3ds, .fbx, .lwo, .obj, .stl, .off, .prefab, .objz), available for VR and AR projection

4. Conclusions

The PestNu digital platform is a valuable tool that connects F2F stakeholders and facilitates the bridging of silos between them, promoting synergies and business opportunities. It allows stakeholders to identify their needs and find the tools and systems necessary for their fields. Furthermore, the platform presents an opportunity for stakeholders to seek advice and guidance, as well as to establish synergistic relationships to advance their objectives. The PestNu Digital platform offers a range of valuable features, including the ability to search for potential partners for B2B or B2C collaborations, investment opportunities, as well as the option to find equipment that meets specific user needs. At M19, the PestNu platform will be ready for testing, with a goal of registering over 1500 F2F stakeholders by M36. Those interested in registering can follow the Business and Investment Opportunities link at <http://pestnu.itι.gr/> and proceed with the registration steps. To achieve the target registration numbers, PestNu will work with its partners to communicate and disseminate the platform effectively.

PestNu digital platform plays a key role in supporting Agriculture 4.0 activities and informing the F2F community about the various tools and services that the project offers. With its wide range of services and resources, the digital platform is an essential tool for PestNu stakeholders. It offers access to valuable information, including best practices, market trends, national plans, training materials, and more. These resources are vital for promoting more sustainable and eco-friendly agricultural practices and helping stakeholders to improve their skills and knowledge in the field. Importantly, the PestNu Digital Platform is not a static platform, but a living one that is always evolving. It will continue to be updated to ensure that it offers the latest and most relevant services and resources. This ongoing evolution is critical for ensuring that the platform remains relevant and valuable to its users. The PestNu Digital Platform is a vital component of the PestNu project, offering a wealth of resources and services to support the F2F community in adopting more sustainable practices and enhancing their knowledge in the field. As such, it will continue to remain an essential tool for the success of the PestNu project, not only during its active phase but also in the years to come, since it will continue to be updated and maintained even after five years of the project's completion, ensuring that it remains a relevant and valuable resource for the F2F community.



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