



## FINAL RESULTS PACKAGE

The BIO4A project ended last June after five consecutive years of intensive industrial demonstration and research activities. Discover here the latest outputs and the final project results.

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### SUSTAINABLE AVIATION FUELS - SOIL CARBON STOCKS AND RECOVERY OF MARGINAL LAND IN DRY MEDITERRANEAN AREAS

After five years of intensive work, the BIO4A project proved the industrial production and distribution of ASTM-certified sustainable aviation fuel from waste lipids, such as Used Cooking Oil and animal fat. It also demonstrated that Camelina, a drought-resistant oil crop, can be a viable solution to produce alternative feedstock for SAF, with low risk of indirect land use change, achieving significant GHG reductions while maintaining or even improving soil health in EU Mediterranean (MED) marginal lands.

**BIO4A - Biofuels for Aviation**, is a Horizon 2020 project launched in 2018 to demonstrate the first large industrial-scale production and use of sustainable aviation fuel in Europe, and to investigate the potential of recovery dry marginal land in Southern EU. More in detail, the goal of BIO4A was to enable the large-scale pre-commercial production of ASTM Certified aviation biofuel from sustainable waste feedstock in the EU, with particular emphasis on **developing production capacity**, and investigating long-term opportunities to supply **sustainable no-food lipids**, through a long-term R&D work, for conversion in low-ILUC biofuels (as per REDII). In doing so, BIO4A adopted a two-pronged approach that was maintained throughout its duration. One prong was the industrial demonstration component, and the other was the research and development work.

## Advanced Sustainable Biofuels for Aviation

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### **Additional industrial capacity, commercial-scale production and distribution of SAF from waste and residual lipids**

In the context of the industrial component of BIO4A ENI - the main industrial partner of the project, **produced commercial-scale volumes of sustainable SAF from residual lipids (1,000 metric tons)**, fully compliant with ASTM standards and regulations on aviation fuels. ENI also managed to **increase the production capacity of SAF**, by building a supplementary process pathway through **HVO-Naphta** and by refurbishing a previously unused distillation column, that is now used for sustainable renewable fuels production. The SAF was then delivered to Schiphol airport in the Netherlands, distributed through standard airport infrastructure and used for commercial flights with business-as-usual methods, through the joint collaboration of partner SKYNRG with KLM.

### **Camelina as a low-ILUC risk feedstock alternative to waste and residual lipids**

The research work was mainly dedicated to developing and evaluating feedstock alternatives to waste and residual lipids. The focus of the work was the sustainable production of virgin lipids from *Camelina sativa*, a drought-resistant oleaginous crop, also grown in combination with biochar as soil amendment, as a strategy to increase soil health and climate resilience in EU dry Mediterranean land. This extensive R&D work also generated many tangible results at all the levels of the value chain. A **new Camelina variety** was selected for its traits of drought-resistance and filed for patent at European level. A new prototype technology for **biochar** production was filed for patenting and is now used for further research and demonstration activities. A 5-year agronomic experiment was set up in Spain and in Italy, in a collaboration between Camelina Company España and RE-CORD Consortium, with various treatments of biochar and Combi (a co-composted mix of biochar and digestate), to determine the optimal quantity to be distributed to **increase crop yields** while contributing to soil health and **increasing carbon stocks**. Results were very encouraging, especially in low-rainfall years, thanks to the use of biochar as a soil amendment.

### **Significant GHG reduction potential from SAF and opportunities for the recovery of marginal land in EU dry Mediterranean areas**

The whole SAF value chain of BIO4A was assessed with a novel LCA approach by CENER, encompassing the whole RED-II compliance scheme. The assessment demonstrated that both traditional SAF value chains based on residual lipids, and value chains supplied by alternative feedstock such as virgin oil from Camelina, can largely outperform the REDII of at least 70% requirement of GHG emission savings with respect to fossil Jet A1. In particular scenarios, for example when using biochar as a soil amendment combined with Camelina cultivation for virgin oil production, the GHG savings can be as high as 107%-128%.

Finally, the environmental and socio-economic effectiveness of the BIO4A pathway was evaluated by EC JRC, producing datasets and maps on vast areas of **marginal and underutilized agricultural land in Southern Europe, suitable for the cultivation of drought resistant oil crops** to produce **feedstock for Sustainable Aviation Fuels**, in rotation with traditional cereal crops, **without reducing food production while increasing the soil organic carbon content**.

## FINAL PUBLICATION: ADVANCED SUSTAINABLE BIOFUELS FOR AVIATION

### SUMMARY OF RESULTS OF BIO4A

This free publication provides a summary of the main results obtained by the different research and demonstration components of BIO4A and their relevance for the current context of SAF deployment.

Topics include:

- Full scale industrial HVO-SAF production from waste feedstock
- Market analysis of waste oil feedstock
- Market outlook: vision, potentials, limitations, and strategy for upscaling
- SAF production in the EU
- Cultivation of Camelina in semi-arid land with a high risk of desertification
- and soil carbon sequestration
- Mapping the potential Camelina yield and environmental sustainability in the EU Mediterranean region for advanced biofuel production
- Biochar as a sustainable management practice
- Sustainability assessment of low-ILUC feedstock SAF value chains at scale

**DOWNLOAD**



## BIO4 RESULTS PRESENTED AT THE EUROPEAN BIOMASS CONFERENCE AND EXHIBITION 2023

### SAF AND LOW-ILUC RISK BIOMASS FEEDSTOCK

This presentation by prof. David Chiamonti, BIO4A project coordinator, provided an extensive overview of the results and the milestones achieved by the BIO4A partners in the production, blending and distribution of SAF at kilotonnes scale. It also illustrated the challenges and solutions for the deployment of feedstock alternatives to waste lipids and oils, obtained from low ILUC risk agricultural biomass, from HEFA pathways. The presentation was part of the EUBCE side event Upscaling the production of low ILUC risk biomass feedstock for the bioeconomy, jointly organized by BIO4A and BIKE projects.



**SLIDES**



**VIDEO**



## USE OF BIOCHAR AS SOIL AMENDMENT ON CAMELINA SATIVA YIELD FOR SUSTAINABLE OIL PRODUCTION

This presentation highlighted the results of a study conducted by BIO4A partner RE-CORD, in which **biochar** from ligno-cellulosic feedstock was tested as a soil amendment in open field trials, alone or mixed with **compost**, and compared with compost alone and mineral fertilisation only.

Field trials were sown with two varieties of Camelina. These were grown simultaneously during the spring-summer period in 2022, in two different locations in Tuscany with different soil texture. Before and at the end of plant cycle, soil was characterized for several physical and chemical properties (e.g. water holding capacity, organic carbon, total and available concentration of macro and micro nutrients). Regarding Camelina, biomass, seed, oil yields and several oil qualitative attributes were determined. Soil in both locations was treated with the same agronomic practices in terms of tillage, sowing density, fertilisation rate.

Results showed that the **highest seed yield performances** in both locations and for the two varieties were found when biochar and compost were applied. Biomass productivity followed the same trend, confirming a good suitability of the biochar and compost-mix as an amendment to support plant growth and development.



[SLIDES](#)



## BIO4A EVENT FUELLING CLEAN AVIATION FOR EUROPE

19 APRIL 2023 - BRUSSELS



EVENT

### Fuelling Clean Aviation for Europe

Scaling up SAF production towards carbon  
neutrality and the EU Green Deal

Slides and recording available



## DELIVERABLES AND PUBLICATIONS

[D 1.1 TECHNICAL SPECIFICATION OF FEEDSTOCK QUALITY](#)

[D 1.3 ASTM CERTIFIED AVIATION BIOFUEL PRODUCTION](#)

[D 2.1 BIOCHAR UNITS FOR AGRORESIDUES](#)

[D 2.2 - RESULTS AND PRODUCT CHARACTERIZATION FOR WOODY AND AGRO-RESIDUE CHARS](#)

[D 2.3 COMPOST AGRONOMIC PROTOCOL OPTIMIZATION TRIAL](#)

[D 2.6 - SELECTED CAMELINA VARIETY PROTECTION AT EU LEVEL](#)

[D 2.7 MAPPING OF SUSTAINABLE POTENTIAL FOR MEDITERRANEAN AGRICULTURAL LAND](#)

[D 2.8 - R&D ON PRETREATMENT REPORT](#)

[D 2.9 R&D TESTS AND PRODUCT CHARACTERIZATION](#)

[D 2.10 - RESULTS ON LYSIMETERS TRIALS](#)

[D 2.11 - RESULTS ON OPTIMAL BIOCHAR AND COMPOST AGRONOMIC PROTOCOL](#)

[D 3.3 - RED II STATUS REPORT 1ST](#)

[D 3.4 RED II FINAL STATUS REPORT](#)

[D 4.1 PROCESS TECHNOLOGICAL PERFORMANCE](#)

[D 4.2 - PRELIMINARY ENVIRONMENTAL ASSESSMENT](#)

[D 4.3 FINAL SUSTAINABILITY ASSESSMENT](#)

[D 4.4 - FINAL REPORT ON THE ASSESSMENT OF ENVIRONMENTAL SUSTAINABILITY INDICATORS](#)

[D 4.5 - SOCIO-ECONOMIC SUSTAINABILITY ASSESSMENT](#)

[D 4.6 - KPIS MONITORING REPORT](#)

[D 4.7 - ASSESSMENT OF SOCIO-ECONOMIC SUSTAINABILITY INDICATORS](#)

[D 5.1 BUSINESS CASE](#)

[D 5.2 - REPORT ON MARKET DYNAMICS](#)

[D 5.3 WASTE FEEDSTOCK MARKET ANALYSIS](#)

[D 5.4 REGULATORY FRAMEWORK PROPOSAL](#)

[D 5.5. MARKET SCALING STRATEGY](#)

[D 6.3 PRELIMINARY PLAN FOR EXPLOITATION AND DISSEMINATION OF RESULTS](#)

[D 6.6 - MID-TERM PROJECT MANAGEMENT PLAN](#)

[D 6.7 - MID TERM PLAN FOR EXPLOITATION AND DISSEMINATION OF RESULTS](#)

[D 6.9 FINAL PROJECT MANAGEMENT PLAN](#)

## PUBLICATIONS

[PRODUCTION AND CHARACTERIZATION OF CO-COMPOSTED BIOCHAR AND DIGESTATE FROM BIOMASS ANAEROBIC DIGESTION](#)

CASINI D., BARSALI T., RIZZO A.M., CHIARAMONTI D., 2019

[POLICY MEASURES FOR SUSTAINABLE SUNFLOWER CROPPING IN EU-MED MARGINAL LANDS AMENDED BY BIOCHAR: CASE STUDY IN TUSCANY, ITALY](#)

CHIARAMONTI D., PANOUTSOU C., 2019

[ASSESSING MARGINALITY OF CAMELINA \(C. SATIVA L. CRANTZ\) IN ROTATION WITH BARLEY PRODUCTION IN SOUTHERN EUROPE, A MODELLING APPROACH.](#)

SCHILLACI C. ET AL., 2023

**DOWNLOAD ALL PROJECT OUTPUTS AT  
BIO4A.EU**

# BIO4A Advanced Sustainable Biofuels for Aviation



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PARTNERS



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