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Evidences from the BIKE case studies

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Efi ALEXOPOULOU

ΚΑΠΕ CRES | CENTRE FOR RENEWABLE ENERGY SOURCES AND SAVING

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BIKE collected and analysed two types of value chains matching the definition for additionality:

a) cultivation in unused, abandoned or severely degraded land

b) productivity increases from improved agricultural practices

Value Chain Type 1:cultivation in unused, abandoned or severely degraded land

- Castol oil for HVO in Italy, Kenya and Greece led by ENI
- Perennial lignocellulosic crops for advanced biofuels in Italy, Greece and UK led by REC

Value Chain Type 2: productivity increases from improved agricultural practices

- Brassica carinata for HVO in Italy, Tunisia and Greece and Uruguay as cover crop in rotation systems with conventional crops led by UPM
- BDR model for lroad, aviation and maritime from decentralized and distributed biomethane production through centralised FT or synthesis in ItalyGreece and UK led by CIB

Task 6.1: Good practice case studies

The following **case studies** have been collected and analysed:

- **CS1**: **Castor oil for HVO** (by growing on unused, abandoned or severely degraded lands) located in Italy, Kenya and Greece; led by **ENI**
- **CS2: Perennial lignocellulosic crops for advanced biofuels** (by growing on unused, abandoned or severely degraded lands) located in Italy, Greece and UK; led by **REC**
- **CS3: Brassica carinata for HVO** (as cover crop, in rotation systems with conventional food crops without replace them) located in Italy, Greece and Uruguay; led by **UPM**
- **CS4: BRD model for liquid biofuels for road, aviation and maritime** from decentralised and distributed biomethane production through centralised FT or synthesis (in rotation systems with conventional crops) located in Italy, Greece and UK; led by **CIB**

Castor bean in Sardinia

Switchgrass in Sardinia

Carinata in Uruguay

BRD model in Italy

➲CS1: Castor oil for HVO (unused, abandoned or severely degraded lands) located in Italy, Kenya and Greece; led by **ENI**

Kenya, Makueni country by Eni (audit)

- **200 ha distributed in 44 villages. KALRO institute and University of Bologna support this project started from 3 varieties, rotations with other oilseeds. Seed yields 1.5 to 2.5 t/ha with oil content 45-50%. Mechanical cultivation is now always feasible in Kenya.**

Italy, Sardinia by Eni (with Bonifiche Ferraresi)

- **Several varieties and densities tested in 2021 & 2022, better yields had been recorded in the high density fields (seed yields of 2.6 t/ha with density >1 plant/m2 in 2021). In 2022, three varieties compared in plots with high density (almost 2 plant/ha) and an demo harvest was organised with a innovative header (Fantini).**

Greece, Velestino by CRES (with University of Thessaly)

- **In 2021 & 2022 an 1ha abandoned field cultivated under no-tillage. C1012 variety was imported by Kaiima company. High plant density was applied (>4 plants/m2). The no-tillage worked very well. Herbicides applied at the end of August to stop growth. Harvesting trials was done with existing machinery but additional actions is needed. Seed yields between 1.5 & 2.5 t/ha.**

Castor bean on abandoned, unused, severely degraded

Case study	Castor bean on abandoned, unused agricultural areas (>1 ha / case study)
Where and how	✖ Velestino (central Greece); 2021, 2022, 2023 ✖ Xanthi (northern Greece); 2021
Cultural practices	✖ Soil preparation; No tillage in Velestino (abandoned area) and conventional in Xanthi (degraded). ✖ No weed control in Velestino on no-till. ✖ C1012 hybrid from KAIIMA was sown. ✖ Basic and top fertilization was applied. ✖ No insects/diseases detected. ✖ In both sites the trials irrigated (either by drip or springer).
Harvesting	✖ Harvesting: a) using sunflower header and/or combine machine for cereals (sunflower header was better). The plants, 10 days before harvesting, sprayed with a herbicide to schedule the final harvest .
Yields and uses	✖ Mean seed yields: 1.5 to 2.5 t/ha ✖ Oil content: 40-45%

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Castor bean at 2 leaves stage

Castor bean at maturity stage, before the spraying to stop crop's growth

Straying castor plantation to stop growth

Castor bean In Velestino (Greece), no tillage

Castor bean at the early growth stages

No tillage sowing at the end of April 2021

The case of switchgrass (abandoned, unused, severely degraded)

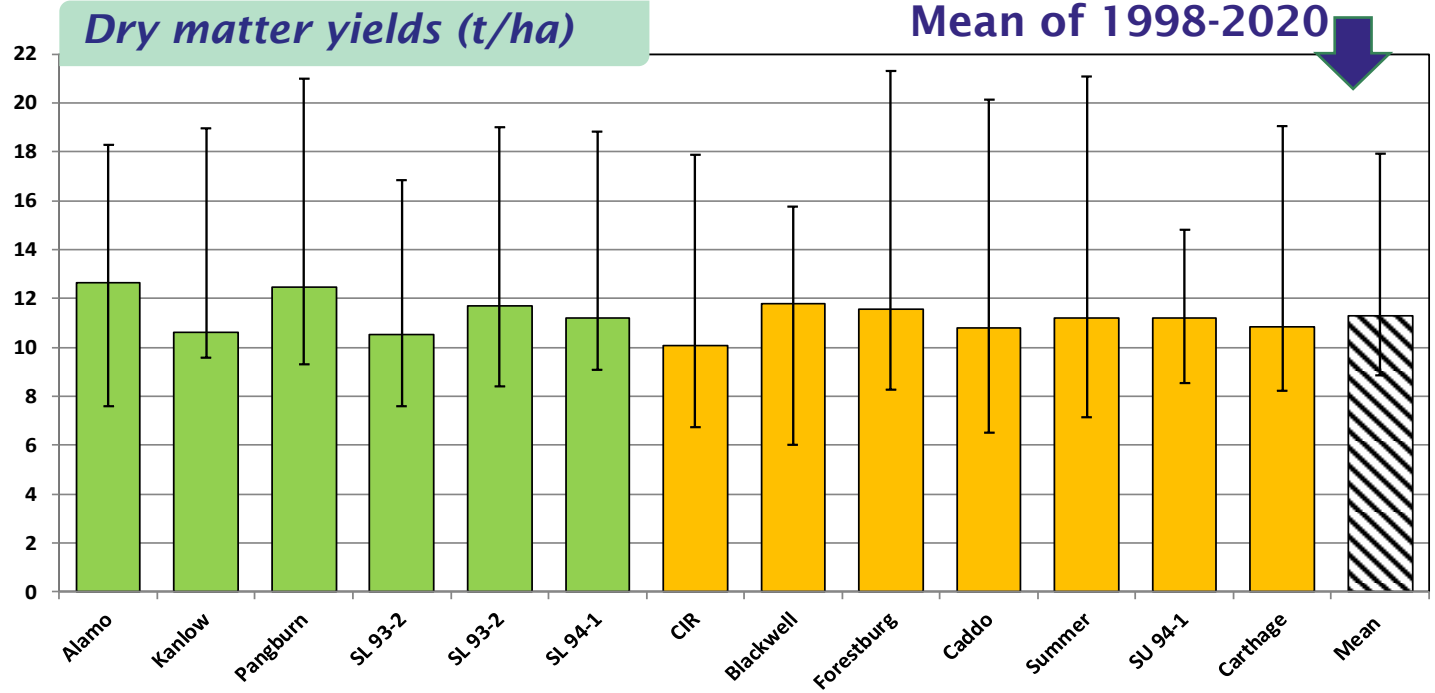
Case study	CRES (Greece)
Where and how	✖ Aliartos (central Greece); The fields established from 1998 t0 2001. The total area was 1 ha
Cultural practices	✖ Soil preparation (harrowing, and plowing). A fine seedbed was necessary due to small seed. ✖ A chemical weed control was done before sowing. ✖ Distances between the rows from 15 to 70 cm. ✖ 300 kg basic fertilizer (11-15-15) before sowing and then every 5 years before regrowth. ✖ Top nitrogen fertilization of 60 kg N/ha every spring (30-40 days from regrowth). ✖ Tested irrigation & fertilization rates, varieties. ✖ No insects/diseases detected. ✖ A piping system was used for irrigation.
Harvesting time	✖ In winter after a killing frost.
Yields and uses	✖ Mean dry biomass yields 12 t/ha (of 20 years); top yields were recorded in years 2 & 3; the dry biomass had 40% leaves; the ash content of the harvested material was 4-5%. The calorific value was 4560 kcal/kg (NCV) 4260 kcal/kg (GCV) .

Early stages of the 2nd growing period (regrowth)

Switchgrass in mid-November

Switchgrass ready for harvest

Dry matter yields (t/ha)



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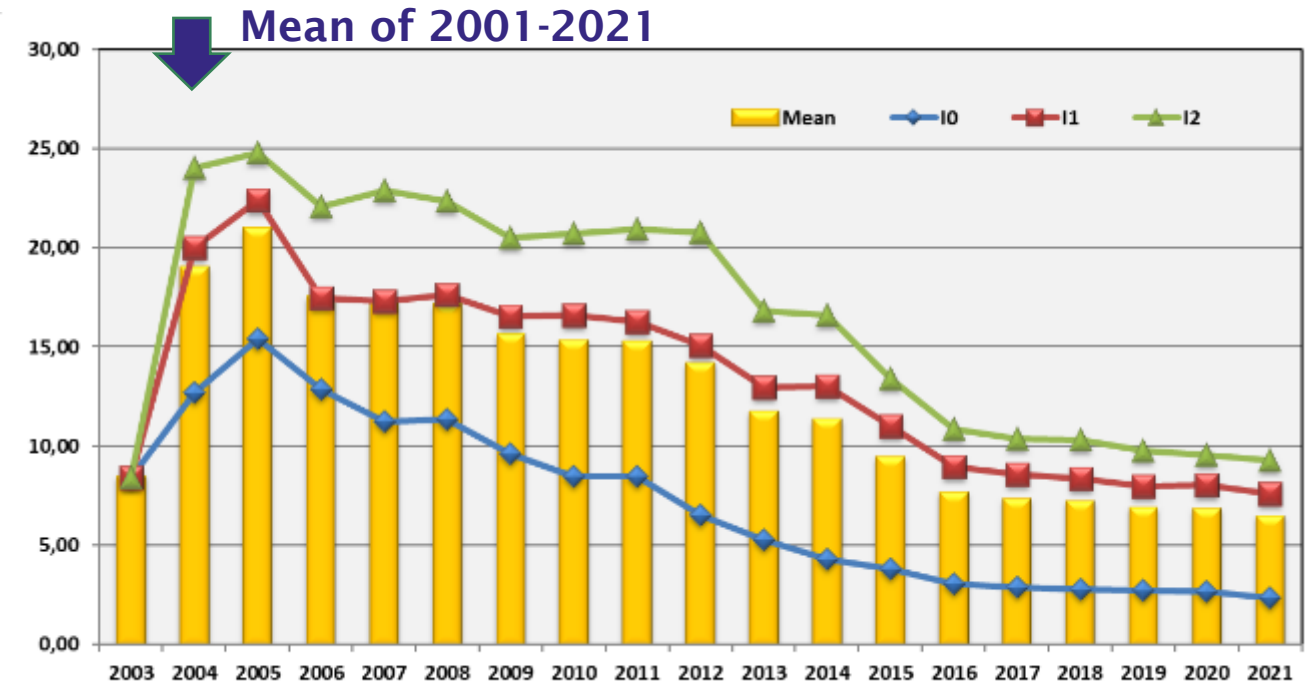
- Dry mean yields (of 22 years) was 11.3 t/ha; ceiling (17.8 t/ha) in year 2.
- Lowland varieties > upland



- The mean yields of 19 years were: 7.1 t/ha (rainfed), 13.4 t/ha (50% of PET) & 16.5 t/ha (100% of PET).
- Ceiling yields recorded in 3rd growing period for all irrigation rates.

The case of miscanthus in UK (abandoned, unused, severely degraded)

- **Miscanthus** established in UK by **Miscanthus Nursery Limited, Lower Marsh Farm** (95 ha of miscanthus) established at different time frames; 2006, 2008, 2020, 2022).
- The harvesting is mainly done with **common corn harvesting machinery**. The harvested material is pressed and supplied in big bales to the clients.
- **Miscanthus Giganteus** is the only officially registered variety of Miscanthus in the UK.
- **Two fields' "Beaches" (4.7 ha) and "Tainfield" (4.82 ha**) were chosen to evaluate if any potential additionalities do occur (audit for BIKE).
- In each site the **harvesting takes place every spring** using direct transport of the material to buyer after the harvest. **The harvested material used for renewable fuels and composites**.

BRK model (productivity increases through improved agricultural practices)

Case study	Italy (Fattoria Della Piana, Candidoni)
Where and how	✖ **CIB / Uliva Societa Agricola S.S. (Uliva)** 96.47 ha used to grow low ILUC-risk crops (in the past was abandoned land). The crops that are being rotated are: corn, sorghum and wheat.
Cultural practices	✖ Reduced tillage (tillage using Vervaet Hydro-trike to distribute with precision bio-digestate) was applied for both corn and grain. ✖ Corn was planted at 75,000 plant per hectare in April and is the primary crop and grain was planted at 200kg/ha in October as a secondary crop. ✖ Chemical weed control was applied ✖ In terms of fertilization 200m^3/ha of bio-digestate. ✖ Corn had to be irrigated during summer. ✖ No insects of diseases detected.
Harvesting	✖ The harvesting was done with New Holland Harvester in September for corn and in March for grain.
Yields	✖ The achieved yields were 50 t/ha for corn and , 30 t/ha for grain.




BRK model (productivity increases through improved agricultural practices)

Case study	Greece (central Greece)
Where and how	✖ Orchomenos (1st year: maize, 2nd year: Sunn hemp, 3rd year: wheat + sunn hemp)
Cultural practices	✖ Soil preparation (traditional); No weed control ✖ Started in December 2020 with durum wheat that harvesting in June 2021. Immediately after, sunn hemp was sown that harvesting in October 2021 and in April 2022 corn will be established that will be harvested in September 2022. ✖ Basic and top fertilization was applied for wheat and corn. ✖ No insects/diseases detected. ✖ A drip irrigation system was established in June 2021 for sunn hemp and it will be used for corn.
Harvesting	✖ Harvesting: Wheat had been harvested with the existing machinery and the same will be done for corn. For sunn hemp the stems had been harvested and stayed in the fields to get dry and they collected a week later.
Yields and uses	✖ Mean seed yields of wheat varied from 5.8 to 6.5 t/ha ✖ The dry yields of sunn hemp varied from 16 to 18 t/ha.

Maize: 11/ha (seeds) + 14 t/ha (straw) – 1st year

Sunn hemp: 24 t/ha (straw) – 2nd year

Double cropping, wheat (5 t/ha seeds + 8 t/ha straw)+ sunn hemp (12 t/ha) – 3rd year

The case of Brassica carinata (improved agricultural productivity)

Case study	Uruguay (UPM)
Where and how	✖ >50.000 ha since 2015 (variety Avanza64); currently 15.000 ha annually; inserted in local rotation systems (mainly soy as summer crop) as winter crop
Cultural practices	✖ No tillage (direct seedling machinery), 80 pl/ha ✖ Chemical weed control; prior and after emergence ✖ No irrigation ✖ Basic ferilization: a) basic (50-70 kg/ha P205 & 50-70 kg/ha N20) and top fertilization: a) 50% 30 DAE and 50 % 60 DAE ✖ No insects/diseases detected.
Harvesting	✖ Harvesting: early October and swathing in the beginning of June ✖ Machinery used was the one used for wheat, barley and soy.
Yields and uses	✖ Mean seed yields: 1500 kg/ha; max of 2700 kg/ha Oil content: 42% of the seeds, high content of erusic acid; used for biodiesel (esterification); certified RSB EU RED ✖ Seed meal used for animal feeding ✖ The straw remaining in the fields for soil health and grain residues (husks) used for bioenergy.

The case of Brassica carinata (improved agricultural productivity)

Case study	Thessaloniki
Where and how	✖ 1 ha, Nea Gonia (Thessaloniki)
Cultural practices	✖ Conventional soil preparation ✖ Chemical weed control; prior and after emergence (spring sowing) ✖ No irrigation ✖ Several insects and diseases detected.
Harvesting	✖ Harvesting: to be done by end of June 2023 ✖ Machinery to be used will be the same used for rapeseed.

Take home messages

- **CS1: Castor oil (growing on unused, abandoned or severely degraded lands)**

The crop performed well and high yields had been recorded (>1.5 t/ha seeds/ha, yields even > 3 t/ha were measured).They are available high yielding hybrids but the mechanical harvest is not well organised yet (the machine collects capsules and additional separation is needed).

- **CS2: Perennial lignocellulosic crops (by growing on unused, abandoned or severely degraded lands).**

Miscanthus works very well in central and north Europe and there are several fields (with total area higher than 25000 ha) where miscanthus is used for bioenergy and bioproducts. In the dry area of the Med region switchgrass performed quite well (with mean yields of 20 years >10 t/ha) having quite lower irrigation needs.

- **CS3: Brassica carinata (as cover crop, in rotation systems with conventional food crops without replace them)**

Carinata performs well in the Med region and can fit to the existing agricultural systems but is having quite long growing cycle that can risk the double cropping per year. It has also several diseases and insects that means additional chemical treatments. Last but not least, it is hard to find high yielding varieties in Europe. One company is controlled the whole breeding.

- **CS4: BRD model** (in rotation systems with conventional crops)

It worked very well in Italy by CIP company. It was tested on abandoned agricultural areas, where corn, cereals and sorghum were rotated. High yields had been recorded and the soil quality had been improved after 9 years activities. In Greece another rotation had been tested (maize-sunn hemp – wheat & sunn hemp) for biomass production and it was found that higher yields had been recorded compared to the conventional rotation system (wheat-maize that leaving the soil uncovered for around 8 months).

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Thank you!

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Bike-biofuels.eu

info@bike-biofuels.eu

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