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# Biodegradable and compostable solutions for agriculture

*For ADB Data Room – CIRCULAR ECONOMY*



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**Section 1 – Novamont: who we are, our business model and solutions**

Section 2 – Solutions for agriculture and crop protection

Section 3 – Integrated solutions: models for the territory



## Who we are

The **Novamont Group** is an industrial company with its roots in the Montedison School of materials science, created to pursue the ambitious project of various researchers: **the integration of chemistry and agriculture.**

Established in 1990, it is today a **Benefit Company, B Corp certified** among the international players in the production of bioplastics and the development **biochemicals** and bioproducts of **renewable origin.**

In 2023, it was acquired by Eni Versalis, Italy's leading chemical company, whose strategy is strongly oriented towards specialising its portfolio also through chemistry from renewable sources.



# Our DNA

Novamont: a group with a triple vocation

## INDUSTRIAL STRUCTURE

### Mater-Bi / Bioplastics

total production capacity

**>170.000** ton/y

### Origo-Bi / Biopoliesters

total production capacity

**>117.000** ton/y

### Bio BDO from fermentation

total production capacity

**30.000** ton/y

### People

~ **650**

### Biomethane

### Tetrahydrofuran - THF

Dielectric oils and  
biolubricants **Matrol-Bi**

### Pelargonic Acid

### Azelaic Acid

(Matrìca - JV Novamont Eni  
Versalis )

## RESEARCH AND DEVELOPMENT

**13**

industrialized  
proprietary  
technologies

of which **4**  
first of a kind

**> 25%**

people dedicated  
to research,  
development and  
innovation  
activities in 2023

~ **1.600**

patents / patent  
applications in  
2023

**135** patent  
families

**3**

research centers

**3**

technology hubs  
with pilot plants  
and demo plants

## TRAINING CENTER

**n.478**

training activities since 1996 for young researchers and expert figures  
multidisciplinary training paths activated with national and international  
universities and research centers.

2022: launch of **OFFICINE NOVAMONT**, a training space  
where collaboration and creativity are emphasized as elements of  
success for the company.

# Circular bioeconomy to regenerate local areas

The three pillars of our circular bioeconomy model



## The reindustrialization of disused sites

Biorefineries built from the reindustrialization of disused or no longer competitive production sites. Development of innovative and sustainable processes that contribute to the decarbonization of the economy.



## The integrated agricultural value chain and scraps valorization

Research and innovation for the development of agricultural value chains with low environmental impact, through the valorization of marginal lands and not in competition with food production. Research and innovation for the transformation of waste and by-products into new bioproducts.



## Products as solutions

Products designed to close the carbon cycle and ensure that no persistent substances accumulate in compost, treated water, sludge, and soil, overcoming the problem of pollution. Products also designed to be reused and recycled.

# Novamont in the World

- Novamont seats
- Sales network
- 📍 BioBag
  - Toronto (Canada)
  - BioBag Americas  
Dunedin (FL, USA)
  - BioBag Baltics  
Tallinn (Estonia)
  - BioBag Finland  
Vantaa (Finland)
  - BioBag International  
Askim (Norway)
  - BioBag Ireland & Uk  
Delgany (Ireland)
  - BioBag Norway  
Askim (Norway)
  - BioBag Polska  
Wroclaw (Poland)
  - BioBag Sweden  
Torsby (Sweden)
  - BioBag Zenzo  
Hillerød (Denmark)
  - Dagoplast  
Kaina (Estonia)



# The agricultural value chain integrated in the local areas

Development of agricultural value chains with low environmental impact



**Novamont has always promoted research projects targeted on different territories according to their specificities.**

- **Promotion of low input oleaginous dry crops able to restore organic carbon in marginal land**
- Training in good soil management practices to promote sustainable agriculture
- Reduced environmental impact on soil and water through the use of: biodegradable mulch films, fitosanitary products based on pelargonic acid, biolubricants for agricultural machineries
- Cascading use of all crop components to make products and co-products ranging from biochemicals to animal feed and to meet the energy needs of the industrial process
- **The collaboration with Coldiretti began more than 10 years ago in the experimental fields of central Italy.**

# Our proprietary technologies

Upstream integration 1990 - 2023

✱ Proprietary technologies brought to industrial scale
 ★ World's first industrialized proprietary technologies industrialized world's first

## RAW MATERIALS OF RENEWABLE ORIGIN      INTERMEDIATES | MONOMERS | POLYMERS      SOLUTIONS

- ✱ Oleaginous dry crops with low input requirements
  - specialised seeds for crushing
  - biomass treatment

- Organic fraction municipal solid waste
- Agro-industrial waste (including exhausted vegetable oils)
- Absorbent hygiene products (cellulose, paper)
- Waste water
- Bio-CO2 from fermentation

Oleaginous dry crops

R&I activities for production from scrap

Renewable raw materials

THF ✱  
FDCA ✱

Chemical processes



Biotech processes

★ BIO-BDO  
Other building blocks from fermentation

★ Azelaic acid  
Pelargonic acid  
Other intermediates



Polyesters Origo-Bi  
*Range of different polyesters*



Complexed starch



MATER-BI ✱

- Bioherbicides **AGER-BI** ✱
- Biolubricants **MATROL-BI** ✱
- Biodegradable cosmetic ingredients **CELUS-BI** ✱



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# Product as solutions

# Application sectors of Mater-Bi

Where biodegradability and compostability represent real added value



## Retail

Carrier bags and fruit and vegetable bags adopted by large retailers can be reused for the separate collection of organic waste



## Waste management

Bioplastics help to improve the management of organic waste, reducing its potential for contamination and thus promoting the production of high-quality compost



## Agriculture

Soil biodegradable products simplify plastic waste management operations and greatly reduce the risk of pollution in a sector where there is a high rate of dispersion into the environment



## Packaging e Foodpackaging

Compostable packaging can be disposed of with organic waste, providing a solution for all the traditional packaging that today cannot be recycled or ends up in organic waste



## Foodservice

Compostable foodservice ware simplifies waste management when it is not possible or practical to use washable and reusable ware, such as at large events or in closed circuits



# MATER-BI

# Mater-Bi

The innovative family of biodegradable and compostable bioplastics with renewable content

## IL MATER-BI



Mater-Bi products are not just products, they are designed to solve specific environmental, economic and social problems, such as the management of organic waste or the pollution and degradation of agricultural soils, creating a virtuous circle with cascading benefits for the community



- 1) **biodegradable and compostable in industrial composting**
- 2) **biodegradable and compostable in home composting**
- 3) **biodegradable in soil** according to major European and American standards: UNI EN 13432, EN 17033 and ASTM 6400



It does not release persistent substances into the environment, has no ecotoxicological effects and **biodegrades at low temperatures**. The main areas of application are waste collection, large retail, food service, packaging and agriculture



The result of an integrated value chain that actively contributes to the **regeneration of land and resources** and facilitates the creation of virtuous cycles for the reuse and recycling of materials



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# Mater-Bi in agriculture

Innovative biodegradable solutions in soil



# Which applications are targets for biodegradable and compostable plastics?



## IN FUCTION OF

Extent of use

Short lifespan (= high turnover)

Difficult/expensive removal

High recycling costs/no possibility of recycling in the area

High possibility of dispersion into the environment

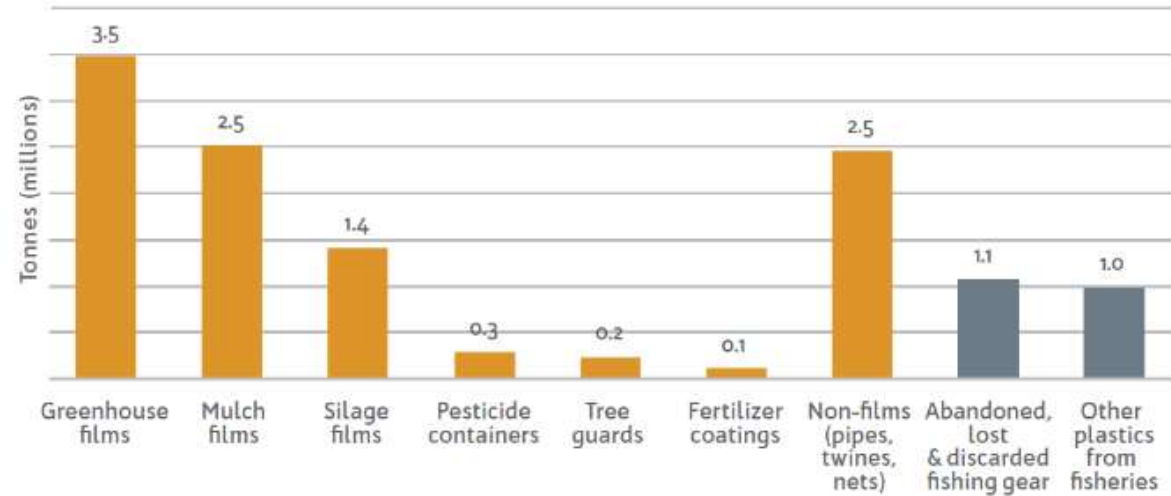
High «soiling»/dirt (% of soil or other inert materials at end of life)



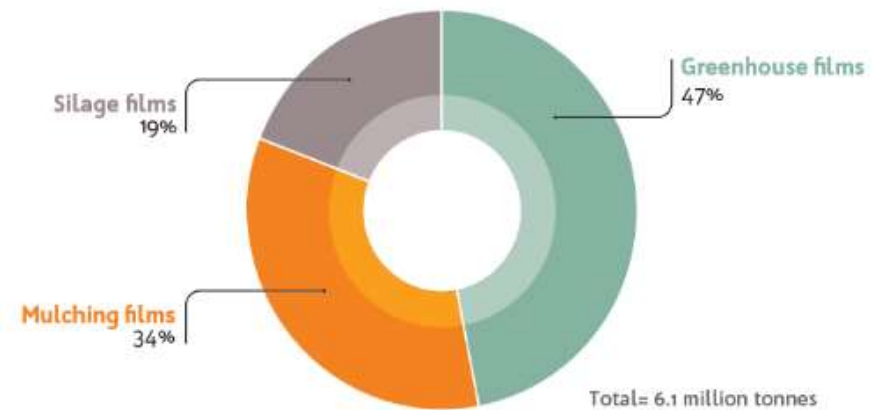
# Plastics in agriculture

- According to the last **FAO's report** (2021) in **agriculture 12.5 Mt plastics/yr** are used, corresponding to **3-5 %** of the total plastic production (**359 Mt/yr**)
- **Films applications** exceed **50% (6.1 Mt)** of the plastics applications in agriculture
- **Plastic mulch films** represent the **second category** of plastic materials used in agriculture (2.5 Mt)
- **LDPE** is the most used plastic material and represents about **80% of the market in 2019**
- At present **biodegradable plastics** represent **about 1 % of the global plastics consumption**

Estimated global quantities of agricultural plastics (FAO, 2021)



Global use of plastic films in agriculture in 2018 (FAO, 2021)





## Plastic waste in agriculture – The European situation



- In EU **1,175 Mt/yr of plastic waste** is produced out of the **722 Mt/yr of agro-plastics** used in agriculture
- Conventional plastics have good recycling potential and specific schemes are being implemented at EU level
- To date in EU, **only 28%** of agricultural plastic waste is **recycled**, while **42%** ends up in **landfill** and the remaining **30%** is recovered as **energy**; **still 34,000 tons/year were burned in the field**
- Agro-plastics are generally very dirty with soil and organic residues ("soiling"); **for mulching up to 67% of the initial weight of the film is soil contamination**
- It is estimated that approximately **133 Mt/yr of agricultural soil** is removed together with the mulch films
- **Clips and threads** are among the most difficult plastic applications to remove at the end of use: it is estimated that approximately **15% of this plastic is burned in the field**

Source: European Commission, A European Strategy for Plastics in a Circular Economy, 2018; Liu EK, He WQ, Yan CR (2014) 'White revolution'to 'white pollution'—agricultural plastic film mulch in China. Environ Res Lett 9(9):091001; Agriculture Plastics Environment (APE); Ben W. Phillips, An Opportunity For Murcia, April 2019 © Regional Government of Murcia, [www.adaptivethinking.green](http://www.adaptivethinking.green); Photo by Ambiente Europeo.

# Mater-Bi soil biodegradable mulch film

## A long journey



- Biodegradable mulch films have been used by growers around the world since **over 20 years** and are a **fully established agronomic solution** for a wide range of crops (with short and medium crops cycle)
- **Many scientific papers and studies** are available on the agronomic effects and field performance on the main crops and in different climatic situations
- **Several research projects** have studied biodegradable mulch films starting from the first EU project (2001) to GRACE Horizon Project (2022)
- The **mode of use and the mechanization** have been fully implemented and growers are able to use with success biodegradable mulch films without changing their agronomic technique
- Some **crops normally grown without plastic** films can benefit from the use of biodegradable mulches (e.g. processing tomatoes, vine)

# Mater-Bi soil biodegradable mulch film

An opportunity also for organic farming



- At the end of the cultivation cycle, Mater-Bi soil biodegradable mulch films **do not have to be collected and disposed of, but have to be incorporated into the soil** where, through **microorganisms**, they biodegrade, transforming into carbon dioxide, water and biomass
- **Reduction** of **labor costs** for removal and disposal
- **Reduction** of potential negative impacts caused by **improper disposal** operations and **landfill**
- Opportunities also for **organic farming** where herbicides are not allowed and weeds control is more difficult: Novamont is the first company to have certified a material according to the «**AIAB Technical Means**» specification

# Biodegradation in soil of Mater-Bi mulch film

## Standards and Certifications

- **OK bio-degradable SOIL** is a certificate awarded to those materials that are completely biodegradable in soil without negative effects (toxicity) on the soil biodegradation substrate – Certificate issued by TÜV Austria
- **EN 17033:2018** - “Plastics. Biodegradable mulch films for use in agriculture and horticulture. Requirements and test methods” - European standard defining:
  - The **characteristics of biodegradable mulch film** in terms of **complete biodegradability** in soil **without negative effects** (toxicity) on the biodegradation substrate (soil)
  - **Characteristics of the finished product** (initial tensile and optical properties) Certificate of conformity issued according to DIN CERTCO protocol
- **ISO 23517:2021** - “Plastics – Soil biodegradable materials for mulch films for use in agriculture and horticulture – Requirements and test methods regarding biodegradation, ecotoxicity and control of constituents”



### CRITERIA FOR BOTH STANDARDS

- ✓ **Biodegradation** (conversion to CO<sub>2</sub>): > = **90% in 24 months** compared to a reference material, measured in soil at room temperature (according to ISO 17056)
- ✓ **Ecotoxicology**: tests on plants, earthworms, nitrification tests
- ✓ **Heavy metal values**: lower than the thresholds established by standards



# AGER-BI

GOLD SUPERSECCO



Ideato e prodotto da



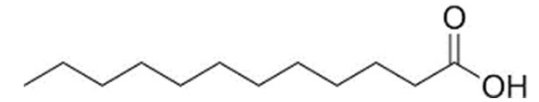
**NOVAMONT**

A Versalis Company

# Novamont's solutions for crop protection

Pelargonic acid becomes AGER-BI

- **Pelargonic acid** is a fatty acid commonly found in nature (geranium species, numerous essential oils, in foods such as apples and grapes..)
- Obtained in the Matrica biorefinery (in Italy) via a **low impact proprietary technology** from **vegetable oils**
- Pelargonic acid is a molecule permitted in both animal and human nutrition as a fragrance additive
- **Rapidly biodegradable in water, sediments** (freshwater and marine), and **soil** (2 days).
- **AGER-BI** is a family of herbicides and desiccant agents developed by Novamont having **pelargonic acid** as active ingredient



# Solutions for crop protection

Unique Pelargonic Acid-based herbicide and desiccant

- **AGER-BI** is the **proprietary pelargonic acid-based formulation**, developed by Novamont and authorized in Italy for different crop applications
- Tested and optimized for a **range of applications** (total herbicide, pre-harvest desiccant, phytoregulator, suckers control) and **crops** (grapevine, tobacco, fruit trees, peanut, alfalafa)
- Characterized by the **highest concentration of active ingredient, low dosage and high stability**, resulting to be **more effective** in controlling weeds compared to benchmark products on the market in agriculture.

Ideato e prodotto da

# AGER-BI

GOLD SUPERSECCO

NOVAMONT  
A Verulco Company

Efficace di Natura

È la natura la nostra formula segreta per un diserbo potente e sostenibile

CONSORZI AGRARI D'ITALIA

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# Soil biodegradable mulch film on processing tomato

## Experience in Italy and Spain



### WHERE WE STARTED FROM

- Italy and Spain are the biggest processing tomatoes producers in EU.
- Plastic mulch films are used in processing tomatoes to **enhance plants growth, improve yield, control weeds** and **optimize inputs** (water, herbicides, fertilizers)
- In **Spain** (Navarra region) mulch films are extensively used and many plastics residues remained in the field after harvesting
- In **Italy** not everywhere plastic mulches were used, due to the impossibility to mechanically harvesting tomatoes in the presence of a plastic mulch

# Soil biodegradable mulch film on processing tomato

Experience in Italy and Spain

## ***EFFECTS OF BIODEGRADABLE MULCH FILMS***

- **Effective control of weeds**, avoiding the use of herbicides, which can compromise the growth of young seedlings
- **Rapid growth of seedlings** in the early stages of the crop cycle
- Approximately **15-20% lower irrigation water consumption**
- **Better root development**
- **Full mechanization from laying to harvest**
- **Yield increase: in quantity (+ 10-30%) and quality**

## **WHERE WE ARE NOW**

- ✓ In **Spain** (Navarra) Mater-Bi mulch films substituted **80% of the plastic mulch films**
- ✓ In **Italy** (Apulia region) **40% of the processing tomato cultivations are covered with biodegradable film**



# Models for the territory – integrated bioplastics solutions

Marina de Cabo Cope – South Spain (Murcia)



## WHERE WE STARTED FROM - THE PROBLEM

In the **Regional park of Cabo Cope** in the South of Spain plastics materials are widely used by the growers to produce vegetables

**Improper disposal** at the end of vegetable season left plastics in the environment and **many residues reached the beaches** and the sea with high level of **white pollution** in the protected area



# Models for the territory – integrated bioplastics solutions

Marina de Cabo Cope – South Spain (Murcia)

## WHERE WE ARE NOW - THE SOLUTION

- In local farms use **certified biodegradable mulch film** and **certified compostable clips and twines** and optimization of conventional non biodegradable plastics end of life
- The **growers positively evaluated** the use of **biodegradable mulch films** and **compostable clips and twines**
- Technical global solutions were proposed to simplify the end of life of **plastic waste**

**Spanish and European legislation** included biodegradable **mulch films** and **compostable clips and twines** certified in accordance with standards (EN 17033 – biodegradable mulch and EN13432 - compostability) among the **environmental solutions** for the possibility of obtaining **subsidies**



# Models for the territory – integrated bioplastics solutions

## Clips and twine for greenhouse production in South Spain (Andalucia)

### WHERE WE STARTED FROM

- Plastic clips and twines are among the most difficult and expensive plastic to be properly disposed of

### WHERE WE ARE NOW

- **Compostable clips and twines** were used in greenhouses conditions on different crops: tomato, cucumber, pepper in trials
- The **functionality** of compostable solutions was **equivalent** to the plastic traditional materials
- The compostable clips and twines at the end of the crop cycles were removed from the greenhouse together with the crop green waste and taken to a nearby **industrial composting plant** where they will be converted in **compost** which can then be used in the fields



# Models for the territory – integrated bioplastics solutions

Bioeconomy project in South Italy (Pantelleria island – Sicily)



- The Pantelleria cultivations are shaped by the extreme environmental conditions
- The most widespread crop is the vine, the **Pantelleria sapling**
- In 2014, UNESCO recognized the importance and uniqueness of the "**Sapling Vine Agricultural Practice**", by listing it on its **Intangible Cultural Heritage List**.
- The Zibibbo grapes, obtained from these vineyards, represent the raw material for the vinification of the prized Passito di Pantelleria.

Source: <https://www.parconazionalepantelleria.it/pagina.php?id=11>



# Models for the territory – integrated bioplastics solutions

Bioeconomy project in South Italy (Pantelleria island – Sicily)



*Farm Vitivinicola Fabrizio Basile- Mater-Bi soil biodegradable mulch films to Zibibbo vine cultivation*



*Farm Donnafugata - Test of greenhouses covering with Mater-Bi clear mulches*



*Punta Spadillo Parco Nazionale dell'Isola Extra-agricultural weeding using Ager-Bi – pelargonic acid-based herbicide*



*Farm Fabrizio Basile- Ager-Bi application in vineyard weeding*



*Antico Capperificio Bonomo & Giglio- Agricultural Mater-Bi soil biodegradable mulch film for caper cultivation*

# Models for the territory – integrated bioplastics solutions

## Banana sleeves in Martinica

### THE PROBLEM

Difficult waste management of plastic waste from banana production (banana bunch sleeves) on an island  
In Martinique 105 ha are cultivated with bananas on a total agricultural area of 113 ha

### THE SOLUTION

Use of **soil biodegradable and compostable bags** to reduce the plastic waste at source and produce organic matter (compost)

**PROJECT CASDAR** financed by ADEME (F)

Different local partners (ECODIAM) plastic producers, Banamart and ARMEFLHOR



Innover pour une Agriculture Durable



Evaluation des performances au champ des gaines biodégradables





# Models for the territory – integrated bioplastics solutions

## Banana sleeves in Martinica

Tests performed on different biodegradable and compostable bags vs conventional bags

Evaluation in terms of:

- **Management** (application and removal),
- **Shelf life** and **protection** (adequate for crops cycle)
- Final **characteristics of the fruits**

No significant difference between traditional and biodegradable/ compostable alternatives



*Biodegradable plastics sleeves in different colours*

## Take home messages

- **Increase of sustainability of the territory** by simplifying the end-of-life, cleaner feedstock materials for composting plants, reduction in using growing inputs such as herbicides, fertilizer, irrigation water and reduction of permanent residues in the environment (substitution of persistent active ingredient)
- **Transition to innovative solutions** needs to look at the **overall costs** (including environmental externalities) and be guided by legislation
- Novamont's solutions proved to be **efficient and robust sustainable alternatives** in terms of **agronomical effects** and **field performance** in various climatic conditions, crops and fully exploitable at commercial scale in many different territories

“The challenge of our millennium is in the balance between the technical means that humanity possesses and the wisdom in how we will make use of them”.

Umberto Colombo

*Thank you for your attention!*



# Models for the territory - Integrated solutions

## Consorzio di Tutela del Prosecco di Conegliano Valdobbiadene

- Founded in 1962, by 11 producers representing the large sparkling wine companies and the main vine-growers' cooperatives, founded the, proposing a set of production regulations in order to protect the quality and image of their wine.
- In 1969 the production of Prosecco was legally recognized and formally regulated by the by the Italian Ministry of Agriculture for the first time.
- The Consortium groups together the producers in the Denomination with the objective of protecting and promoting Conegliano Valdobbiadene Prosecco Superiore both in Italy and around the world.
- In 2009, with the reorganisation of the Prosecco denominations, the Ministry of Agriculture classified Conegliano Valdobbiadene as a Denominazione di Origine Controllata e Garantita (D.O.C.G.) area, the highest level of quality for Italian wines.



# Models for the territory – integrated bioplastics solutions

Bioeconomy project in North Italy (Veneto Region)

Memorandum of understanding between **Symbola, Consorzio Valdobbiadene Prosecco Superiore DOCG** and **Novamont** for the study and implementation of technical solutions for the **transition to sustainable agriculture** in the Prosecco Superiore production area transition to sustainable agriculture – **soil biodegradable mulch films and pelargonic acid-based herbicide**



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DI PADOVA



Tear-off mulch film system

