Miscanthus in the European bio-economy: a network analysis
PRESENTATION PLAN

① Introduction
Scientific context
Study goals

② Methodology
Systematic review protocol
Bibliometric network analysis

③ Results
Analysis of the current situation of the development of miscanthus sector
Organisation of miscanthus-related research

④ Conclusions
Transition Towards Bio-Based Economy

Growing world’s population
Climate change concerns
Adaptation of production systems to the increasing food and energy demands

Policies related to interdependent sectors from agriculture and forestry, food, feed, bioenergy, biotechnology, and green chemistry

Bio-Based Economy

1) Availability of large quantities of sustainably-produced and efficiently-mobilised biomass
2) Development of alternative and innovative production technologies ensuring cost-effectiveness in biomass transformation

This project has received funding from the European Union’s HORIZON 2020 research and innovation programme under Grant Agreement No. 669062
Interest for Miscanthus sp. as Biomass Crops

- Suitable for marginal areas, miscanthus has:
  1. a relatively long rotation period (at least 15 years);
  2. a strong yield potential (high efficiency in the conversion of solar energy into biomass);
  3. excellent environmental conservation attributes (reduction of soil erosion and nutrient leaching, protection of wildlife habitat, improvement of soil organic matter).

- Characterised by an efficient nutrients uptake and low requirements due to its perennial rhizome system.

Stand of M. giganteus on Caveny Farm, Monticello, Illinois. Photo: John Caveny (1 mark/line = 30 cm)
STUDY GOALS

• Several research studies have been carried out to promote the development of miscanthus sector, to assess and improve its potential and performance and, therefore, to provide solutions to barriers to widespread miscanthus-based energy and materials.

• Though, the future of this crop, in Europe, is still unclear and doubts remain about its interest from agronomic, environmental, socio-economic and industrial perspectives.

⇒ We investigate the literature on the deployment of miscanthus in different research areas to provide a statement on whether the promotion of its production should continue and strengthen.

⇒ A network analysis, combined with a systematic review, is performed to better understand the research orientation and identify the key factors in propelling the development of miscanthus sector.
This project has received funding from the European Union’s HORIZON 2020 research and innovation programme under Grant Agreement No. 669062. Call: H2020 WIDESPREAD-2014-2015, topic: WIDESPREAD-2014-2 ERA Chairs

METHODODOLOGICAL PROTOCOL

1. Scopus → 2985 papers
   Keywords: Miscanthus x giganteus, Miscanthus sinensis, M. sacchariflorus, Miscanthus hybrids, etc.

2. Scopus → 1942 papers
   12/25 Subject areas.
   Language: English
   Type: journal articles, book chapters, books and conference proceedings

3. SCREENING
   METAGEAR PACKAGE
   Titles & Abstracts

4. Bibliometric network analysis
   Collaboration network
   Co-occurrence network

1720 selected papers

VOSviewer
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Fig 1: Worldwide evolution of the annual scientific production of publications on miscanthus from 1953 to 2018
Fig 2: VOSviewer map of author keyword co-occurrence network built basing on fractional counting method.

(Out of 4233 identified keywords, only 165 meet the minimum threshold of 5 occurrences. Only 100 keywords that represent the greatest total weight are displayed.)
<table>
<thead>
<tr>
<th>10 central keyword clusters</th>
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| **Is *M. giganteus* a sustainable source?**  
(554 occurrences) |
| High establishment cost; Sensitivity of yields to soil quality; Energy dependence on harvest date; Biogas being more cost-efficient option for farmers; Early harvest may improve the sustainability of biogas sector |
| **Biomass conversion technologies**  
(195) |
| 2 main BCT: combustion and thermal processes; Importance of pyrolysis; Production of biochar, bio-oil and syngas; Biochar having good potential for energy production and C sequestration; Bio-oil having similar cost as distillate fuel |
| **An environmentally-friendly energy crop**  
(159) |
| Efficient nutrient uptake; Dead leaves helping to sustain SOM; Low N requirements; Low GHG emissions; High C sequestration |
| **Potential for bioenergy**  
(133) |
| Excellent feedstock for bioenergy; Improving of yield potential, establishment conditions, cultivation techniques; Testing other species and genotypes having better water-use efficiency and cheaper vegetative multiplication phase |
| **Miscanthus-based biofuel**  
(100) |
| Low farmers’ willingness; absence long-term contracts; Problems related to quality; sensitivity to water stress-marginal land; cell wall composition and combustion quality depending on agronomic treatments |
| **Miscanthus vs Switchgrass**  
(79) |
| Lignocellulosic crops +/- same agronomic and environmental features; 3 competition levels: resources (land/water/ecosystems), costs, end-use |
| **Lignin**  
(52) |
| Responsible for recalcitrance to chemical and enzymatic hydrolysis; Several pretreatment technologies and strategies aiming to separate the components and break down the lignin |
| **Biochar (BC) & contaminated soil remediation**  
(38) |
| Potential for phytoremediation of heavy metal contaminated soils; Use of miscanthus BC w/ lime to sequester heavy metals and improve microbial enzymatic activity and grass growth in acidic mine spoil |
| **Land Use Change**  
(33) |
| Cultivation on marginal land and low biodiversity areas; Management of grasslands; Use of Eddy covariance for CO₂ exchange between ecosystem and atmosphere; Insignificant change in grassland’s SOC |
| **Impacts on biodiversity**  
(14) |
| Importance of miscanthus in the agricultural landscape; Increase of wildlife resources; Abundance and high diversity levels of earthworm, flies, beetles, pollinating insects (bees, wasps), and birds |
Fig 3: VOSviewer map of country co-authorship network built basing on fractional counting method
(76 countries have been identified. Grouped into 5 clusters, only 39 countries meet the threshold of 5 documents per country.)

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Organisation of collaboration network over time

Fig 4: VOSviewer map of average publication production per year in the country co-authorship network built basing on fractional counting method.

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PRODUCITIVITY GAP BETWEEN EU COUNTRIES: BEFORE AND AFTER 2010

Spatial distribution of number of papers produced in the EU

Before 2010

After 2010

Number of papers
- [5, 7)
- [7, 9)
- [9, 13)
- [13, 17)
- [17, 23)
- [23, 55)
- [55, 89)
- [89, 146)
- [146, 226]

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**IMPORTANCE OF RESEARCH FUNDING IN PROPELLING Miscanthus sector: case of France**

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<tr>
<th>Associations</th>
<th>Communities</th>
<th>Companies</th>
<th>Euro. Funds</th>
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**FUTUROL Project Funded by BPIFrance**

Implementation of an industrial 2G ethanol pilot on a biorefinery site

Public and Private institutions dedicated to funding research on miscanthus from 2002 to 2018 in France
Main key factors in propelling miscanthus-related research:

• Collaborations between sector-involved actors either from the same or different countries have been taken into place 1) to transfer the knowledge and therefore and to fill in the observed productivity gap between countries, and 2) to enhance the actor network and cope with current obstacles and create new methods and competitive and innovative technologies.

• Economic, environmental, energy and geopolitics concerns have shaped the development of miscanthus sector through climate-energy polices

• Policy is a key factor influencing public funding and collaborations in the network, thereby shaping research (Policy -> Research).

• Policy-makers can use the available knowledge or rely on funding of research to implement more effective policies (Policy < Research).

• Policy and research are mutually influencing each other in the sense that knowledge does not only address governance issues, but also causes further ones (Policy <-> Research).
Investigation of literature has revealed that:

- Miscanthus is a promising crop for the development of the bio-based economy.

Production processes of bio-chemicals from lignocellulosic feedstock.

=> There is still more to do to widespread its cultivation and to develop more cost-efficient and environmentally-friendly conversion processes allowing an optimum use of all biomass components.
THANK YOU FOR YOUR ATTENTION