ISB CNR - Istituto per i Sistemi Biologici

BioEconomy

biological sources for a sustainable world

CNR
Area della
Ricerca Roma 1
6 marzo 2019

Montelibretti
Area della Ricerca
di Roma 1

Dipartimento Scienze
Bio-Agroalimentare

ISBN 978-88-97987-21-5

Dipartimento Scienze Bio-Agroalimentare

CNR - Istituto per i Sistemi Biologici

BioEconomy

biological sources for a sustainable world

CNR Area della Ricerca Roma 1
6 marzo 2019

ISBN 978-88-97987-21-5

Curatela: Angelo Ferrari, CNR ISB.
Web Developper: Stefano Tardiola, CNR ISB.
Web Server Management: Giorgio Giardini, CNR ISB.
Grafica: Alessandro Tozzi, CNR ISB.
Segreteria organizzativa: Antono Berti, Simona Boccuti, Laura Lilla, Massimo Quici, Aldo Rosati, CNR ISB.

In copertina: cardo dei lanaioli (d*ipsacus fullonum)*

Index

Bioeconomy

biological sources for a sustainable world

Presentation

Giovanna Mancini

CNR- Istituto per i Sistemi Biologici, Area della Ricerca Roma1

The European Commission defines bioeconomy as '*the production of renewable biological resources and the conversion of these resources and waste streams into value added products, such as food, feed, bio-based products and bioenergy*'. As a consequence bioeconomy deeply involves the fields of agrifood and green chemistry, but it also cross-cuts fields such as the use of forests, biotechnologies, the production of biomaterials and bio-energies, thus addressing societal challenges such as environment remediation, issues connected with climate changes, the production of new drugs, the need of food for an increasing population. All this involves a profound change of both the objectives of research and the management policies that should have an integrated and transversal approach. From these requirements it follows the demand of a proper formation that should be integrated and interdisciplinary.

The workshop *Bioeconomy: biological sources for a sustainable world* is the opportunity to bring up the various facets of this new approach of economy, discuss about the state of the art of bioeconomy in Lazio region, in Italy and in Europe, and share the on going activities and skills in CNR scientific network.

Bioeconomy

biological sources for a sustainable world

4

Invited lectures

Bio-economy - A challenge of knowledge integration for the Society 5.0

Laura De Gara

Campus Bio-Medico University of Rome, Via Alvaro del Portillo, 21, 00128 Rome

l.degara@unicampus.it

The history of human beings has been characterized by events in which human ability to learn from nature has opened new scenarios and determined great changes in life conditions, giving rise to real social and cultural revolutions.
The first revolution, which generated what we might call "Society 1.0", has been the domestication of plants and animals. The discovery of agriculture that occurred between 13000 and 8000 years ago in different parts of the planet, allowed human beings to abandon nomadic lifestyle and to build the first stable settlements. Interestingly, the main centers of crop domestication also coincided with the areas where the great cultures of the ancient world developed (Maya and Aztec civilizations are strongly linked to the maize domestication, Chinese civilization to the rice domestication, while the great civilizations born in the so-called Fertile Crescent to the wheat domestication)[1,2].
The evolution of human societies went on as a result of progressive subsequent discoveries. Indeed, the life conditions of groups of people progressively improved. However, only the end of XVIII century saw the beginning of "Society 2.0" ; when the industrial revolution affected the lifestyle of entire populations by increasing human capability to produce goods and services through the substitution of human and animal work with machines.
In the middle of XX century with the discovery of antibiotics and, even more, with their industrial production, a new paradigm introduced humanity to the "Society 3.0". This possibility had a huge impact on human health allowing to overcome illnesses up to that point lethal.
Since the '90, we have entered in the "Society 4.0". In this case, the diffusion of computer science and internet have determined the change of paradigm by modifying networking

possibilities and interaction speed as well as the relation of human being with things (IoT). In the next years, the new frontiers of artificial intelligence are supposed to strongly change several activities that had been considered, up to now, typical of human being.

The evolution of human lifestyle has determined a constant increase in the consumption of natural resources. Moreover, anthropic activities have irreversibly changed the natural environment. It has been calculated that our ancestors of the Stone Age needed a consolidated amount of 4000 calories *per capita*, while nowadays, a person requires 228000 calories for his/her daily life [3].

Now, the big challenge of scientific research is to produce food and other goods using energy, water and other natural resources in a more efficient way.

A sustainable global economy is necessary to support an increasing request for food all over the planet and to improve, globally, human living conditions. Probably this is not possible without a new paradigm leading humanity towards Society 5.0. As in the case of the first revolution, which arose from the capability of our ancestors to copy what happened in nature, research must take inspiration from the mechanisms evolved for regulating energy fluxes in natural ecosystems, where a kind of energy is transformed in another and where waste is an unknown concept.

The key words of Society 5.0 are “smart”, artificial intelligence, but even sustainability, right relation between human needs and environment, between natural and artificial. In this context, bio-economy is of key relevance. Indeed, the aim of bio-economy is exactly to redefine our models of production and consumption so that humanity’s needs do not overcome the capacity of ecosystems [4].

How does a competent bio-economist professional acquire the necessary knowledge and skills? Currently, there is no academic degree preparing this kind of expert. Bio-economy requires the capability to integrate specific competences (from agronomy, biology, chemistry, engineering etc.) with the capacity of linking different productive chains by using the waste or by-product of one of them as a resource for another one. A bio-economist must also find the meeting point between human and environment needs as well as to enhance ecosystem services for improving sustainability of the productive chains.

In this speech, I discuss knowledge and skills required to become professionals able to work with a bio-economic approach. Particular attention will beis given to the capability to cope with multidisciplinary problems and complexity, to combine innovation and social responsibility, creativity and sustainability, globalization and strong connection with the local territory.

References

1. Naturale artificiale coltivato - L’antico dialogo dell’uomo con la Natura – Euresis, Frimedia s.r.l. 978-88-97129-03-5 ISBN, www.tespi.net, 2013

2. Diamond J. Evolution, consequences and future of plant and animal domestication. Nature 418: 700-707, 2002

3. Morris I. Why the West rules – For now: the patterns of history, and what they reveal about the future. Toronto Mc Clelland & Stewart, pp. 626-9, 2010

4. Bastioli C. Bioeconomia per la rigenerazione dei territori. Edizioni Ambiente ISBN 978-88-6627-222-9, p. 28, 2018

6

Bioeconomy in Europe and in Italy: the Italian Bioeconomy strategy and the opportunities offered by the EU Commission for sustaining it

Fabio Fava

Alma Mater Studiorum-Università di Bologna; IT Representative, a) Horizon2020 SC2 Programming Committee, b) States Representatives Group, PPP Biobased Industry (BBI JU) and c) BLUEMED Initiative WG, EuroMed GSOs, Brussels. DICAM. U. Terracini, 28. 40131. Bologna, Italy

Bioeconomy is the economy associated with all sectors producing biomass, i.e., agriculture, livestock, forestry, fisheries and aquaculture, and the sectors processing it, such as, the food industry and the biobased industry. The latter is consisting of the wood processing and the pulp and paper industry and biorefinieries, conversting non food biomass and biowaste in novel or innovative products for the modern pharma, chemical, cosmetic and energy industry. They all together are making in Europe 2,3 Trillion euros per year of turnover and 18,0 Million of jobs. In addition to this, Bioeconomy contributes to the reduction of the dependence of current European industry from fossil fuels, preventing biodiversity losses and land use changes, and regenerating rural, coastal and former industrial areas by locally creating new economic growth and jobs. Further, Bioeconomy can provide solutions to the increase of food requested by the increase of global population and of the adverse effects of climate change on ecosystems, biodiversity and water resources. It also permits to valorize by-products and waste from the primary production sectors and the food and biobased industries, with the production of bio-based chemicals, materials and fuels, thus preventing their environmental impacts and producing valuable compounds that one day can return their natural carbon back to the soil. This is the circularity offered by Bioeconomy and its clear contribution to the achievement of the standards of resource saving and CO_2 emission reduction planned for the coming years.

Given the economical, social and environmental relevance of Bioeconomy, the European Commission recently launched a new Bioeconomy strategy to further boost it in all European Member States (https://ec.europa.eu/commission/news/new-bioeconomy-strategy-sustainable-europe-2018-oct-11-0_en). Germany, France, Italy, United Kingdom, Spain, Finland, Ireland and Belgium developed their own national Bioeconomy strategy during the last few years.

Italy is the 3rd Bioeconomy in Europe, with 260 Billion euros per year of turnover and 1,7 Million of jobs. Moreover, it is the 2nd European Country as presence in the research and innovation Bioeconomy projects funded by the European Commission under the Societal Challenge 2 of Horizon 2020 and the Public Private Partnership "Biobased Industry". In addition, Italy displays a quite rich terrestrial and marine biodiversity and prominent private and public actors working in the different Bioeconomy sectors. Unfortunately, such actors and sectors are fragmented as the national policies, funding programs and infrastructures. To reduce such a fragmentation and better exploit the national Bioeconomy potential, Italy launched a National Bioeconomy Strategy in 2017 (http://old2018.agenziacoesione.gov.it/it/S3/Bioeconomy.html). It was coordinated by the Italian Presidency of Council of Ministers and endorsed by 5 Ministries, all Regions, the Agency for Territorial Cohesion and the most relevant national technology clusters. It includes a research, innovation, and policy agenda aiming at increasing 20% of the current turnover and employment of italian Bioeconomy by 2030 by a) sustainably improving the productivity and quality of products of each biomass production and biomass transformation sectors, and more efficiently interconnecting the latter, by creating longer and more locally routed value chains, where the actions of public and private stakeholders integrate across major sectors; b) better exploiting national terrestrial and marine biodiversity, ecosystem services and circularity, and c) regenerating abandoned or marginal lands and former industrial sites. Further, the strategy includes actions addressed to promote Bioeconomy in the Mediterranean area for a greener and more extensive local production of food and bioproducts, and a wider social cohesion and greater political stability in the area. The National Technology Clusters of Bioeconomy, such as the cluster Agrifood (CLAN), that on Green Chemistry (SPRING) and the one on Blue Growth (BIG), will play a key role in the implementation of the strategy on the nation territory.

The Basilicata Cluster of Bioeconomy in the context of the regional Smart Specialization

Francesco Cellini
Agenzia Lucana di Sviluppo e di Innovazione in Agricoltura - Centro Ricerche Metapontum Agrobios, Metaponto di Bernalda (MT)

8

The socio-economic and the natural territorial profile has great importance in shaping the bioeconomy value chains that can be developed in a specific context. Bioeconomy is indeed strongly dependent on local (i.e territorial) biological and natural resources. as well as on local productive assets. The engagement of stakeholders and local actors is key for the success of a sustainable bioeconomy approach.
Basilicata Region finalized a Smart Specialization Strategy based on Research and Innovation (RIS3) that identified Bioeconomy as one among five industrial sectors of development. So far, Basilicata is the Italian region that has indicated Bioeconomy as a well-defined strategic sector, coherent with the European and, more recently, national visions. Basilicata has accentuated rural characteristics: with a population density of 57 inhabitants per Km^2, total agricultural land exceeds 700 thousand hectares, and forests cover more than 400 thousands hectares. Basilicata, with its 5 rivers and 12 reservoir dams, has also got availability of water for irrigation. Basilicata has a strong potential of biomass production that is largely unexploited.

Basilicata RIS3 identifies five development trajectories:

1. Water management in the agroindustry chain.
2. Genomic research for an agriculture sustainable, smart and integrated.
3. Nutrition and Health.
4. Green chemistry.
5. Non technological innovation.

Basilicata RIS3 indicates a specific territorial soft governance organization having the scope of engaging organizing the relevant stakeholders for the development of bioeconomy: the cluster.
Cluster Lucano di Bioeconomia (CLB ETS), is a no profit association established in September 2018 that has the mission of promoting bioeconomy in Basilicata, and supporting the development of the agro industrial sector. CLB has a typical triple helix constitution: research and academia, industry and public authorities work together to share a common vision and to develop specific R&D and value chain projects. CLB ETS has 66 members, with a large prevalence (60) of the private sector, mainly SMEs.
CLB can count on excellent R&D assets and research infrastructure (RI) that can foster SMEs development. One RI on high throughput plant phenotyping by imaging, unique in Italy, is the national node of Phen-Italy, the Joint Research Unit part of EMPHASIS, the ESFRI project on European strategic research infrastructures.
CLB has recently supported and stimulated R&D projects among its members on new agro industrial value chains based on special crops, with the idea of both attracting external investments and supporting local enterprises.

An Urban Biorefinery to convert organic waste into bio-based plastics: the H2020 RES URBIS project

Mauro Majone
Dipartimento di Chimica, University of Rome "La Sapienza"

email of presenting author: mauro.majone@uniroma1.it

Considering the strong EU commitment towards full implementation of a European circular economy, it is necessary to extend and to improve available options for resource recovery from the organic fraction of waste of urban origin, especially towards higher value products than energy and compost.

Indeed, huge amounts of organic residues originate from the separate collection of urban solid waste (OFMSW) and the sludge from urban wastewater treatment plants (WWS). Although OFMSW and WWS originate from the same urban area and contain similar amount of organic carbon and of similar nature, these two streams usually are managed separately.

In this frame, The RES URBIS project (RESources from URban BIo-waSte) is a 3-year Research and Innovation Action funded under the H2020 Programme (Call CIRC-05, Grant agreement 730349), which aims at making it possible to convert several types of urban bio-waste into valuable bio-based products, in an integrated single biowaste biorefinery and by using one main technology chain.

Started in January 2017, RES URBIS comprises 21 participants from 8 European countries, including academic and research institutions, companies and public institutions.

Urban bio-waste includes the organic fraction of municipal solid waste (from households, restaurants, caterers and retail premises), excess sludge from urban wastewater treatment, garden and parks waste, and possibly selected waste from food-processing (if better recycling options in the food chain are not available).

Bio-based products include polyhydroxyalkanoate (PHA) and related PHA-based bioplastics as well as ancillary productions: biosolvents (to be used in PHA extraction) and fibers (to be used for PHA biocomposites).

The feasibility of the proposed concept will be investigated in four territorial clusters, in different European countries (Italy, Portugal, Spain, and United Kingdom) and present different characteristics. Each clusters has an experimental platform that is being operated by using a representative "cocktail" of urban bio-waste for the respective cluster.

Territorial and economic analyses will be done either considering the ex-novo implementation of the biowaste biorefinery or its integration into existing wastewater treatment or anaerobic digestion plants, with reference to clusters and for different production size. The economic analysis will be based on a portfolio of PHA-based bioplastics, which will be produced at pilot scale and tested for applications:

- Biodegradable commodity film
- Packaging interlayer film
- Speciality durables (such as electronics)
- Premium slow C-release material for ground water remediation

Forest and Wood Bioeconomy

Giuseppe Scarascia-Mugnozza

DIBAF, Università della Tuscia, Viterbo

A livello mondiale, le foreste ricoprono il 31% della superficie delle terre emerse e costituiscono una risorsa irrinunciabile per la società umana, producendo legname, cibo, fibre e medicine per le economie più industrializzate. Le foreste sono anche una riserva per la biodiversità, costituendo l'habitat per l'80% delle specie vegetali e animali del nostro Pianeta.

Anche in Europa il settore foresta-legno è estremamente diversificato e multifunzionale, fornendo una vasta gamma di materiali e prodotti, bio-energia, attività ricreative e altri preziosi servizi ambientali, derivanti dalle foreste. Gli alberi generano benefici economici, ambientali e sociali, interamente basati su risorse rinnovabili; i prodotti forestali sono, infatti, riciclabili e riutilizzabili per nuove trasformazioni industriali e, alla fine del ciclo produttivo, possono essere convertiti in energia, sostituendo combustibili fossili, da fonti non rinnovabili. Pochi settori possono giocare un ruolo fondamentale nella bioeconomia circolare, europea e mondiale, come la filiera forestale.

A sua volta, la filiera foresta-legno italiana è caratterizzata da una notevole rilevanza economica e tecnologica, ma anche da molte contraddizioni. La più rilevante è la mancanza di integrazione tra attività forestali e industria del legno: infatti, l'Italia utilizza oltre 40 milioni di m^3 (Mm^3) di prodotti forestali e ne importa dall'estero l'80%, per soddisfare il proprio fabbisogno di materia prima legno e cellulosa; l'Italia, pertanto, copre con le importazioni gran parte del proprio fabbisogno di materia prima industriale ovvero di legname, legno per energia, prodotti semilavorati come i segati, la cellulosa e anche carta e cartone riciclati. E' quindi comprensibile che uno squilibrio così evidente, tra le esigenze dell'industria italiana di trasformazione, con grandi potenzialità di sviluppo per la bioeconomia forestale, e la capacità produttiva di materia prima nazionale, non pesi soltanto sulla bilancia valutaria del Paese ma renda anche più fragile l'industria, troppo dipendente dai rifornimenti e dalle scelte di mercato di numerosi Paesi stranieri, che a volte sono anche nostri temibili concorrenti industriali. Peraltro, i nuovi regolamenti europei sulle restrizioni al commercio di legname (FLEGT), proveniente da Paesi esterni all'Unione Europea dove la gestione forestale è poco sostenibile e i tagli sono spesso condotti illegalmente, determineranno ulteriori limitazioni alle importazioni in Italia dei prodotti forestali e difficoltà di approvvigionamento e di reddito alla nostra industria.

Comunque, l'industria italiana del legno-arredo e della carta-editoria è una delle più importanti a livello mondiale, contribuendo in misura rilevante alle esportazioni italiane e ai livelli occupazionali nel nostro Paese. La nostra industria di trasformazione del legno comprende oltre 70.000 imprese che occupano 400.000 addetti, realizzando un fatturato annuo di 40 miliardi di euro ed esportando il 35% circa della produzione. Anche l'industria della cellulosa e carta è una realtà economica di grande peso con un fatturato globale di oltre 7,6 miliardi di euro, 200 imprese e oltre 20.000 occupati. La filiera foresta-legno-carta è quindi una delle principali realtà industriali del nostro Paese, con importantissime ricadute in termini di posti di lavoro, eccellenza tecnologica, potenzialità di ricerca e innovazione, e fonte di reddito dal momento che la bilancia valutaria del settore è decisamente in attivo, per quasi 8 miliardi di euro. Si tratta di una realtà molto diversificata, in genere caratterizzata da imprese di piccole e medie dimensioni ma anche con strutture imprenditoriali molto avanzate e di consistenti dimensioni, con forti investimenti tecnologici e di assoluta eccellenza anche nel panorama internazionale.

In conclusione, le foreste non svolgono soltanto l'importante funzione di fornire servizi ecologici di fondamentale importanza per la biosfera e la società umana ma anche un ruolo rilevante per la produzione di materia prima rinnovabile ovvero di bio-risorse per l'attività industriale, ed economica in generale, la vera green economy o bioeconomia. Agli alberi e alle foreste viene quindi chiesto di fornire, in misura sempre crescente, legname per l'industria dell'arredamento, del mobile e della carta, per le strutture edilizie, per le energie rinnovabili e per la produzione di nuovi composti e materiali innovativi anche ad alto valore aggiunto. Il sistema industriale italiano del legno detiene, infatti, una leadership riconosciuta a livello internazionale; "la questione ambientale" rappresenta quindi una grande opportunità per il settore, soprattutto in virtù delle proprietà uniche della materia prima legno.

Bibliografia

Forest Europe, UNECE and FAO. State of Europe's Forests 2011 (Ministerial Conference on the Protection of Forests in Europe, 2011).

Fortunati, E., Yang, W., Luzi, F., Kenny, J., Torre, L., Puglia, D. (2016). Lignocellulosic nanostructures as reinforcement in extruded and solvent casted polymeric nanocomposites: an overview. Eur. Polym. J. 80:295–316.

Frangville, C., Rutkevicius, M., Richter, A.P., Velev, O.D., Stoyanov, S.D., Paunov, V.N. (2012) Fabrication of environmentally biodegradable lignin nanoparticles. Chemphyschem 13:4235–4243.

Intergovernmental Panel on Climate Change. Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC, 2013)

Mattsson, T., Azhar, S., Eriksson, S., Helander, M., Henriksson, G., Jedvert, K., Lawoko, M., Lindström, M.E., McKee, L.S., Oinonen, P., Sevastyanova, O., Westerberg, N., Theliander, H. (2017). The development of a wood-based materials-biorefinery. BioResources 12:9152–9182.

Paletto, A., Giacovelli, G., Matteucci, G., Maesano, M., Pastorella, F., Turco, R., Scarascia Mugnozza, G. (2017) Strategies for the promotion of the forest-wood chain in Calabria (southern Italy): the stakeholders' point of view. Forest@ 14:34–48.

Ragauskas, A.J., Beckham, G.T., Biddy, M.J., Chandra, R., Chen, F., Davis, M.F., Davison, B.H., Dixon, R.A., Gilna, P., Keller, M., Langan, P., Naskar, A.K., Saddler, J.N., Tschaplinski, T.J., Tuskan, G.A., Wyman, C.E. (2014) Lignin valorization: improving lignin processing in the biorefinery. Science 344:1246843.

Russo, D., Macrì, G., Luzzi, G., De Rossi, A. (2016) Wood energy plants and biomass supply chain in Southern Italy. Procedia Soc. Behav. Sci. 223:849–856. Wall Model Compounds. Available at URL http://www.glbrc.org/databases_and_software/nmrdatabase/ (accessed Feb 10, 2018).

Zikeli F., Vinciguerra V., Taddei A.R., D'Annibale A., Romagnoli M., Scarascia Mugnozza G. (2018) Isolation and characterization of lignin from beech wood and chestnut sawdust for the preparation of lignin nanoparticles (LNPs) from wood industry side-streams. Holzforschung 72, 961.

Zikeli F., Vinciguerra V., D'Annibale A., Capitani D., Romagnoli M., Scarascia Mugnozza G. (2019) Preparation of Lignin Nanoparticles from Wood Waste for Wood Surface Treatment. Nanomaterials 9, 281; doi:10.3390/nano9020281

Bioeconomy

and the food systems

The Circular Economy applied by insects: the Black Soldier Fly Experience

M. Meneguz[a], F. Gai[b], A. Schiavone[c], M. Renna[c], L. Gasco[a]

[a] Depart. of Agricultural, Forest and Food Sciences. University of Turin, L.go P. Braccini 2, 10095, Grugliasco, Italy
[b]Institute of Science of Food Production, National Research Council, L.go P. Braccini 2, 10095, Grugliasco, Italy;
[c]Department of Veterinary Science, University of Turin, L.go P. Braccini 2, 10095, Grugliasco (TO), Italy;

email of presenting author: marco.meneguz@unito.it

FAO estimates that one third of total food production is wasted during its processing [1]. The EC Directive 2008/98 [2] establishes unequivocally the order of priority in the choice of waste treatment: first their reuse, second their recycling, third their energy recovery and finally - as a last choice - their landfill disposal. Toward a Circular Economy approach, insects can be an optimal solution to avoid disposals, as they can be used as bioconverters to recovery nutrients from waste [3]. This innovative sustainable strategy leads to the production of new valuable products. Indeed, insect larvae can be used as innovative raw material in substitution of conventional protein sources in animal feeds thanks to their high nutritional value in terms of protein, fat, chitin, vitamins and minerals contents [4-5]. Insects are also claimed to be highly sustainable because they have optimal conversion indexes, limited ecological footprint, low water requirements and low emissions of greenhouse gases [6]. An insect species adapted to live in decaying organic matter is the Black Soldier Fly (*Hermetia illucens* L., BSF). Its ability to manage and reduce large quantities of manure, food waste and food by-products has been proven [7].
After an overview describing the potential of BSF larvae as bioconverters, the presentation will show the results of Meneguz et al. (2018) [8] who evaluated how wastes can be used as rearing substrates by BSF larvae. Four rearing substrates belonging to organic wastes (a mixture of vegetable and fruit or a mixture of fruits only) and to agro-industrial by-products (brewery and winery by-products) were tested on BSF larvae development, waste reduction efficiency, and nutritional composition. Overall, results showed that vegetable and fruit wastes, and winery by-product can be used as substrates for BSF larval mass production. Moreover, the brewery by-product led to very promising larval performance and nutritional composition.

1. A. Van Huis, J. Van Itterbeeck, H. Klunder, E. Mertens, A. Halloran, G. Muir, P. Vantomme. *Edible insects: future prospects for food and feed security.*, **2013**, 1-201.
2. EU, W. F. D. Directive 2008/98. **2008**.
3. K. C. Surendra, R. Olivier, J. K. Tomberlin, R. Jha, S. K. Khanal, *Renewable Energy*, **2016**, *98*, 197-202.

4. L. Gasco, S. Dabbou, A. Trocino, G. Xiccato, M. T. Capucchio, I. Biasato, D. Dezzutto, M. Birolo, M. Meneguz, A. Schiavone, F. Gai. *Journal of Animal Science and Biotechnology*, **2019**, *10 (4)*: 1-9.
5. S. Dabbou, G. Gai, I. Biasato,M. T. Capucchio, E. Biasibetti, D. Dezzutto, M. Meneguz, I. Plachà, A. Schiavone. *Journal of Animal Science and Biotechnology*, **2018**, *9 (1)*, 49.
6. A. Van Huis, D. G. Oonincx, *Agronomy for Sustainable Development*, **2017**, *37 (5)*, 43.
7. K. B. Barrágan-Fonseca, M. Dicke, J. J. van Loon. *Journal of Insects as Food and Feed*, **2017**, *3 (2)*, 105-120.
8. M. Meneguz, A. Schiavone, F. Gai, A. Dama, C. Lussiana, M. Renna, L. Gasco. *Journal of the Science of Food and Agriculture*, **2018**, *98*, 5776–5784.

The contribution of agrosilvopastoral systems for bioeconomy in Italy

Antonello Franca,[a]

[a] CNR ISPAAM, Trav La Crucca 3, Reg. Baldinca, 07100, Sassari, Italy

email of presenting author: antonio.franca@cnr.it

Agroforestry is considered as one of the cornerstones of the European bioeconomy, and a major contributor to climate change mitigation. There are significant opportunities to benefit from agroforestry for European bioeconomy. Agroforestry is an important European land use equivalent to almost 9% of the agricultural area and it's dominated by silvopastoral systems, particularly wide-spread in the Mediterranean region, such as the montados and dehesas in Portugal and Spain, where livestock grazes between spaced oak trees, providing wood, cork and fodder for the animals. Currently in Italy, there is estimated to be 1,304,600 ha of land that integrates trees on livestock farms and the use of livestock in forests (e.g. forest grazing) and orchards. Most of these systems are located in inlands, mountain areas, at high risk of land abandonment. On the other hand, scientific literature and outcomes clearly evidence the relevance of ecosystems services provided by such systems in terms of commodities productions (raw materials, bio-energy, high quality animal products) and environmental benefits (biodiversity, carbon sequestration, fire prevention, etc.). Considering the case study of Sardinia (Italy), an overview on the main management and valorization practices of agro-silvo-pastoral system is presented, with final remarks on research and policy agenda, in order to promote initiative for better address the role of agroforestry in Italy in facing some of the socio-economic and environmental problems that rural inlands are suffering, in the framework of Italian agriculture greening and in realizing the goals of green economy.

Acknowledgments: Research from the European Community's Seventh Framework Program under Grant Agreement No. 613520 (Project AGFORWARD).

A circular economy approach to omega-3 extraction

Rosaria Ciriminna,[a] **Antonino Scurria**,[a] **Claudia Lino**,[a] **Giuseppe Avellone**,[b] **Mario Pagliaro**[a]

[a] Istituto per lo Studio dei Materiali Nanostrutturati, Consiglio Nazionale delle Ricerche, via Ugo La Malfa 153, 90146, Palermo, Italy;
[b]Dipartimento di Scienze e Tecnologie Biologiche Chimiche e Farmaceutiche, Università degli Studi di Palermo, via Archirafi 32, 90123, Palermo, Italy

email of presenting author: rosaria.ciriminna@cnr.it

We have discovered a circular and green approach to the production of fish oil rich in omega-3 nutrients from the leftovers of anchovy fillets based on solid-liquid extraction using *d*-limonene as biosolvent.[1] Frozen anchovy leftovers obtained from a fillet manufacturing company are mixed with *d*-limonene in a blender. Upon blending and centrifugation, the liquid fraction is collected and transferred to a rotary evaporator to remove the solvent under reduced pressure. Valued limonene is almost entirely recovered and reused in subsequent extraction run. The analysis of the residual oil shows that *d*-limonene is able to extract both eicosapentaenoic acid (EPA) and docosahexenoic acid (DHA) in their natural (triglyceride) form. The oil is rich in vitamin E and the ratio *n*-3/*n*-6 (>10) is considerably higher than the *n*-3/*n*-6 ratio (<7) observed for example in Turkish anchovies.[1] The method offers several environmental, economic and health benefits. Omega-3 fatty acids indeed play a critical role in human nutrition. Following recommendation by the leading national and international health authorities to restore proper *n*-6/*n*-3 ratio,[2] omega-3 fatty acids DHA and EPA derived from fish oil are widely consumed across the world as dietary supplements offering numerous health benefits to children and adults. The main source of omega-3 long chain polyunsatured fatty acids is blue fish, and the large increasing demand of fish oil poses serious sustainability problems related to uncontrolled fishing and biodiversity threats.[3] On the other hand, most of the residues of fish processing, although rich in precious omega-3, are usually discarded as waste (only in the process of fish filleting up to 60% of the fresh fish is cut off and generally disposed of as waste).[4] Furthermore, traditional extraction processes are energy intensive and use organic solvents. Green and sustainable alternatives are needed with the aim to significantly expand and improve the production of omega-3 extracts,[4] especially with the aim to obtain these essential polyunsaturated fatty acids from fish processing waste available in >20 million tonnes/year amount.

The new extraction process based on limonene closes the materials cycle and opens the route to full valorization of an important biological resource so far mostly discarded as waste. Limonene in fact is a renewable biosolvent obtained from waste orange peel.[5] The terpene is also a safe food ingredient endowed with antimicrobial, antifungal, anti-oxidant, anti-inflammatory and anti-carcinogenic properties, widely used in the food industry, making its use ideally suited to produce omega-3 extracts from fish and seafood processing waste.

Fulfilling the bioeconomy principles, significant economic opportunities benefiting local communities, the ecosystem and public health are anticipated.

1. R. Ciriminna, A. Scurria, G. Avellone, M. Pagliaro, *Preprints* **2019**, 2019020023.
2. A.P. Simopoulos, L.G. Cleland (Ed.s), *Omega-6/Omega-3 Essential Fatty Acid Ratio: The Scientific Evidence*, Karger, Basel: 2003.
3. P. Greenberg, *The Omega Principle*, Penguin Random House, New York: 2018.
4. R. Ciriminna, F. Meneguzzo, R. Delisi, M. Pagliaro, *Sustain. Chem. Pharm.* **2017**, 5, 54.
5. R. Ciriminna, M. Lomelli, P. Demma Carà, J. Lopez-Sanchez, M. Pagliaro, *Chem. Commun.* **2014**, 50, 15288.

Edible jellyfish: introducing to a new sustainable food system

Antonella Leone[a], **Stefano Predieri**[b]

[a] Istituto di Scienze delle Produzioni Alimentari, ISPA-CNR, via Monteroni, 73100, Lecce, Italy;
[b] Istituto di Biometeorologia, IBIMET-CNR, via Gobetti 101. Bologna

email of presenting author: s.predieri@ibimet.cnr.it

Jellyfish plays an important role in marine ecosystem and, through the process of carbon sequestration and transport, contributes positively to climate regulation (1). However, human activities and climate change are enhancing jellyfish populations increase, addressed as a threat for the future of the oceans, with economic impacts on fishing and tourism also in Mediterranean Sea. The project GoJelly (EU project-H2020-BG-2017, N. 774499) is studying how jellyfish, a potential threat and/or hazardous waste, can become a valuable resource for new bioeconomic models. Especially in Eastern countries jellyfish are regarded as delicious and healthy food (2) (3) and the finding that also Mediterranean species can provides nutraceutical and antioxidant substances (4) (5), could open new perspective in the local fishery. Climate change and bio-resources variation urge for bring forth a transition towards more sustainable food consumption. Human security and prosperity depends on the inextricable connections between environment, economy and society as well as environment health depends on the way humankind lives and exploits the planet's resources. Scientific knowledge and research about potential new food resources can help society to face this challenge. This study investigated Mediterranean jellyfish as food for Western people, by conducting sensory evaluation on *Rhizostoma pulmo* prepared with five food-processing alternatives. The CATA (check-all-that-apply) sensory test, was chosen, with judges trained in seafood quality, evaluating visual, smell, textural and chemesthesis attributes and product acceptability. Key sensory attributes perceived during jellyfish consumption were identified, and included sea and shellfish aroma, a slick/slippery, rubber- or jelly- like, melting texture, with salt as the dominating taste.
Treatments reducing the salty intensity and providing a solid, crunchy, texture, e.g. steam cooking, helped this food-to-be to reach quite positive evaluations, providing data useful to design jellyfish-based novel food.

[1] Doyle TK, Hays GC, Harrod C, and Houghton JDR. 2014. Ecological and societal benefits of jellyfish. In: Pitt KA and Lucas CH (Eds). *Jellyfish blooms*. Dordrecht, the Netherlands: Springer.
[2] Hsieh, Y-H, Rudloe, J, 1994. Potential of utilizing jellyfish as food in western countries. *Trends Food Sci. Technol.* 5, 225–229.
[3] Hsieh, Y-H., Leong, F-M, Rudloe, J, 2001. Jellyfish as food. *Hydrobiologia* 451, 11–17.
[4] Leone, A; Lecci, RM; Milisenda, G; Piraino S. 2019. Mediterranean jellyfish as novel food: effects of thermal processing on antioxidant, phenolic and protein contents. *European Food Research and Technology*, (EFRT-18-1295.R1) in press.
[5] De Domenico, S; De Rinaldis, G; Paulmery, M; Piraino, S; Leone, A. 2019. Barrel Jellyfish (Rhizostoma pulmo) as Source of Antioxidant Peptides. *Mar. Drugs* 2019, 17, 134.

Controlled hydrodynamic cavitation as a tool to enhance the properties of biological sources

Francesco Meneguzzo,[a] **Lorenzo Albanese,**[a] **Alfonso Crisci,**[a] **Federica Zabini**[a]

[a] HCT-agrifood Lab, Institute of Biometeorology, National Research Council, 10 via Madonna del Piano, I-50019, Sesto Fiorentino (FI), Italy.

email of presenting author: f.meneguzzo@ibimet.cnr.it

Controlled hydrodynamic cavitation (HC) techniques and processes have been increasingly implemented, either as single unit operation systems, or integrated with other technologies, to boost the process efficiency and yields in an ever-growing variety of technical fields. Wastewater treatment and drinking water disinfection, biomass preprocessing, and crude oil refining are relatively well-established application fields. However, HC techniques have shown surprising performances with biological raw materials related to the food, agricultural and forestry sectors and resources. In food processing, HC techniques have been implemented as single unit operation, carrying out particle grinding, homogenization, liquid pasteurization or sterilization, degassing of undesired volatile compounds, as well as enhancing saccharification, creating stable nanoemulsions, when applicable, and extraction of valuable bioactive compounds. Beyond complying with the principles of green extraction, HC techniques have shown a clear superiority over most of competing techniques, including acoustic cavitation, thermal and pressure treatments. At the Laboratory for agri-food applications of controlled hydrodynamic cavitation (HCT-agrifood Lab), important results were achieved in different technical fields, such as food liquids pasteurization,[1] beer brewing,[2,3,4] with a related patent,[5] followed by the development up to the industrial scale,[6] extraction of fir needles in aqueous solutions, resulting in extremely enhanced antioxidant activity,[7] enhancement of biochar properties,[8] and others. Clear advantages over competing techniques were identified for all the above-mentioned applications, such as in terms of process time, energy consumption, and extraction of bioactive compounds.

1. L. Albanese, R. Ciriminna, F. Meneguzzo, M. Pagliaro, *Energy Sci. Eng.*, **2015**, *3*, 221.
2. L. Albanese, R. Ciriminna, F. Meneguzzo, M. Pagliaro, *J. Clean. Prod.* **2017**, *142*, 1457.
3. L. Albanese, F. Meneguzzo, in *Production and Management of Beverages* (eds. A. M. Grumezescu, A. M. Holban), **2019**, 211.
4. L. Albanese, F. Meneguzzo, *Processing and Sustainability of Beverages* (eds. A. M. Grumezescu, A. M. Holban), **2019**, 319.
5. F. Meneguzzo, L. Albanese, **2016**, Patent No. WO/2018/029715.
6. http://www.cavibeer.com/
7. L. Albanese, A. Bonetti, A., L. P. D'Acqui, F. Meneguzzo, F. Zabini, *Foods*, **2019**, *8*, 65.
8. L. Albanese, S. Baronti, F. Liguori, F. Meneguzzo, P. Barbaro, F. P. Vaccari, *J. Clean. Prod.* **2019**, *210*, 159.

Bioeconomy

and agriculture

Cultivation of Cardoon, biomass species for green chemistry, with a circular economy approach

Salvatore Antonino Raccuia,[a]

[a]CNR - Institute for Agricultural and Forest Systems in the Mediterranean - Catania, 58, Empedocle Street, 95128 Catania, Italy.

email of presenting author: salvatore.raccuia@cnr.it

Since the early 2000s, CNR ISAFOM has been involved in different research activities aimed at cultivating the cardoon (Cynara cardunculus L.) as a new biomass crop. While in the first years of activity the research objective was aimed almost exclusively to energy production (1), in the last 6/8 years, the interest has focused on the potentiality of this species for the realization of new cultivation systems with low input intended to produce biomass, grains and roots for green chemistry in marginal areas of the Mediterranean environment applying a Bio economy criterion. The cornerstone of these researches, carried out with the support of several projects in collaboration with important industries in the sector, is represented by the possibility that the products obtained from the entire plant can be used for the realization of a model of Biorefinery compatible with the territory applying a circular economy approach, respecting the use of natural resources.
The cultivation of the thistle allows to have considerable advantages from the point of view of the use of resources thanks to the fact that its production cycle can be completed in the condition of dry farming. The useful products obtained from the thistle made up of oleaginous grain with a good protein content, lignocellulosic biomass, roots rich in inulin and the presence of bioactive molecules in almost all the components of the biomass, allow its full exploitation to support different production sectors. Among the main sectors interested in this species we mention the bio-plastics supply chains to produce mulching cloths and bio-chemicals to produce various products including bio-lubricants, bio-herbicides, in addition to the production of protein meal for animal husbandry that represent an interesting co-product with high added value (2). Many of these products are directly expendable in the agricultural sector with a circular economy approach. More specific research conducted at the CNR ISAFOM in Catania showed that the cultivation of cardoon destined for bio-refining, takes advantage of the organic substance supplied with the distribution of Municipal Solid Waste (MSW) compost with a significant increase in the carbon stored in the soil (3).
Lastly, it should not be forgotten that it is a multi-year crop that requires limitation of soil tillage and entirely covers the soil with its biomass during the rainy season, for which there

are clear advantages linked to the mitigation of erosion phenomena in the internal hilly areas. This can represent an additional advantage in the presence of the intensification of extreme weather phenomena induced by climate change. The results of the research conducted allow us to say that it is possible to build on the thistle, a virtuous and realistic cultivation system, able to maximize the agricultural crops through a sustainable use of resources respecting the environment, to create innovative products consistent with the development of an eco-compatible bioeconomy.

1. Raccuia, S.A. and Melilli, M.G. 2007a Biomass and grain oil yields in Cynara cardunculus L. genotypes grown in a Mediterranean environment, Field Crops Research 101(2):187-197
2. Genovese, C., Platania, C., Venticinque, M., Calderaro, P., Argento, S., Scandurra, S., & Raccuia, S. A. (2016). Evaluation of cardoon seeds presscake for animal feeding. Acta Hort, (1147), 323–328.
3. Razza, F., Sollima, L., Falce, M., Costa, R. M. S., Toscano, V., Novelli, A., Ciancolini A., Raccuia, S.A. (2016). Life cycle assessment of cardoon production system in different areas of Italy. Acta Hort, (1147), 329–334.

The CNR and hemp chain: a new opportunity for Agriculture in Southern Italy.

Giuseppe Sorrentino [a], Anna Tedeschi [a], Luca Vitale [a], Vincenzo Aurilia [a], Giacomo Mele [a], Laura Gargiulo [a], Maria Grazia Volpe [a], Francesco Siano [a], Maria Riccardi [a], Bruno Di Matteo [a], Maria Soprano [b], Fabiana Piscitelli [c], Agata Rascio [d], Domenico Cerrato [d], Giorgio Matteucci [a]

[a] *Department of Biology, Agriculture and Food Sciences (DiSBA)- National Research Council (CNR)- Piazzale Aldo Moro 7 00185 Roma,* ITALY –
[b] *Department of Department of Earth and Environment - National Research Council (CNR)- Piazzale Aldo Moro 7 00185 Roma,* ITALY.
[c] Department of Chemical Sciences and Materials Technologies- *National Research Council (CNR)- Piazzale Aldo Moro 7 00185 Roma,* ITALY.
[d] Council for Research in Agriculture and Agricultural Economics- *Industrial Crops- SS 673 71121 Foggia ITALY*

email of presenting author: *giuseppe.sorrentino@isafom.cnr.it*

Italy is the first country in Europe for the development of the circular economy and the cultivation of hemp can represent a strong driving force for the development of sustainable agriculture with high added value. Because of its high degree of environmental sustainability, hemp is considered an eco-compatible plant with a strong action to contrast desertification and climate change and therefore particularly suitable for crops in the organic field. This crop may be for those beneficiary territories that in the past received aid for crops that have caused negative effects on the environment the new sustainability frontier, even if the agro-industrial chains are to be rebuilt, after a period of about 70 years in which cultivation has been suspended.
The Law of 22 November 2016 which reintroduced the possibility of cultivating Cannabis Sativa L. can encourage the reactivation of agro-industrial chains that can allow all the different parts of the plant to be used as seeds (for oil and flour in the agri-food sector), stem (for the fiber in the textile sector and the canapulo in the industry of green building) and inflorescences in the par para pharmaceutical sector. The CNR-DiSBA, thanks to its multidisciplinary approach, has started several research activities mainly concentrated in the agronomic and in the food sector. Agronomic studies in the Mediterranean area have

demonstrated a greater adaptability of hemp to salt soils compared to other renewal crops such as maize, showing a lower reduction in agronomic yield when the electrical conductivity of the soil increases from 2 ds / m^{-1} to 7.5 ds / m $^{-1}$. A more recent study has also shown that hemp treated with partially organic fertilizers such as UREA compared to synthetic ones such as ammonium nitrate (NH_4NO_3) favors greater biomass development, better seed quality and at the same time reduce N_2O emissions from the ground to the atmosphere. So the crop is well suited to Southern Italy agriculture that has many soils subject to desertification phenomena and whose climate has already far exceeded the limits imposed by the Paris agreements (COP21). Research for the food sector it has been demonstrated that the seeds and the hemp flour of cv. Fedora have a higher polyphenols content than oil which, however, has an optimal omega 3 / omega 6 ratio of 3 and is very rich in phytosterols content. Finally, even if the legislation has not yet defined the maximum values of tetra idro cannabinol (THC) allowed in food (it is hypothesized between 2 and 5 mg / kg), its value has been determined in a beer produced with a hemp inflorescence. THC was found to be absent while the beer presented quantities of other non-psychotropic cannabinoids such as CBG (1ng / ml), CBDV 3.5 (ng / ml), and CBD 5.2 (ng / ml) which had beneficial effects on human health. CBD and CBDV are molecules with beneficial effects on neuronal functions linked to cognition activity.

Bibliografy

La filiera della canapa ed il Consiglio Nazionale delle Ricerche – Atti del Convegno Nazionale – Roma 21 ottobre 2016- CNR Edizioni **2017** Piazzale Aldo Moro 7 Roma ISBN: 978 88 8080 238-9.

Francesco Siano, Stefania Moccia, Gianluca Picariello , Gian Luigi Russo, Giuseppe Sorrentino, Michele Di Stasio, Francesco La Cara, Maria Grazia Volpe. **2019**. *Comparative Study of Chemical, Biochemical Characteristic and ATR-FTIR Analysis of Seeds, Oil and Flour of the Edible Fedora Cultivar Hemp (Cannabis sativa L.).* Molecules 24, 83; doi:10.3390/ molecules 24010 83. *Pp-1-17.*

Multifunctional agriculture for bioeconomy: chlorophyll-deficient crops for climate change mitigation

Lorenzo Genesio[a], Ryan M. Bright[b], Giorgio Alberti[c] and Franco Miglietta[a]

[a] Institute of Biometeorology of the National Research Council (CNR-IBIMET), Via Caproni 8, 50145 Florence, Italy; [b] Norwegian Institute of Bioeconomy Research, 1431 Ås, Norway; [c] Department of Agricultural, Food, Environmental and Animal Sciences, University of Udine, Via delle Scienze 206, 33100 Udine, Italy;

email of presenting author: l.genesio@ibimet.cnr.it

Agriculture plays a key role in climate regulation and appropriate management strategies and productive systems have the potential to significantly contribute to climate change mitigation. This can be made through the reduction of direct and indirect GHG emissions and through the increase of carbon sequestration in agricultural agroecosystems. But Shortwave Radiation Management schemes (SRM), capable to modify the radiative balance of the planet, can also be an option to effectively fight global warming. SRM can be implemented in agriculture via the introduction of highly reflective crops. This study reports a set of laboratory and field experiments aiming at the assessment of the radiative forcing that can be attained, from local to global scales, by the use of a highly reflective Chlorophyll-deficient soybean variety. Our results demonstrate the significant mitigation

potential of such a strategy that comes, however, at the expenses of moderate reduction in yields. The experimental framework also enabled to formulate realistic explanations of the eco-physiological mechanisms that origin the observed yield-gap, and thus to identify specific targets for future plant improvements. Our study demonstrates that critical innovation based on bioresources can contribute to meet one of the most challenging objectives of our times.

Biochar for Bioeconomy

Francesco Primo Vaccari[a]

[a] Institute of Biometeorology, National Research Council, Via G. Caproni, 8, 50144, Firenze, Italy;

email of presenting author: f.vaccari@ibimet.cnr.it

The Biochar is completely included in the Bioeconomy definition provided by Lewandowski (1) that define the Bioeconomy as: “the sustainable and innovative use of biomass and biological knowledge to provide food, feed, industrial products, bioenergy, and ecological and other services. As such, it has the function of providing sufficient food of adequate quality and renewable resources to a growing population and at the same time making sustainable use of natural resources”.
Biochar is a carbon-rich product obtained through carbonization of biomass as it for instance occurs during pyrolysis and pyro gasification. Biomass cracking reactions at high temperature which are used to produce renewable energy (syngas), generate a solid product, the biochar and a viscous black liquid (tar). Biochar can be produced at large industrial facilities, farm and even at the domestic level using pyrolysis technologies that are commercially available.
According to Woolf et al. (2) the global implementation of biochar-based carbon sequestration can potentially offset 12% of current anthropogenic CO_2-C equivalent emission. The long-term stability of the biochar was demonstrated to be greater compared to non-pyrolyzed organic matter that was incorporated into soils with the same environmental conditions. The biochar has an approximate mean residence time in the soil more than 1000 years and this long-term stability is a fundamental prerequisite to consider biochar as a suitable method for carbon sequestration. At the same time the biochar is well recognized to be a soil amendment that increase the soil fertility in terms of physical and chemical characteristic, contributing to enhance the biological soil fertility. The biochar application in agriculture has well-documented beneficial effects on soil and crops, driving an overall increase in soil ecosystem services. The incorporation of biochar into agricultural soil may alter the main physical-chemical properties by inducing alkalization, and base cation content and its liming effect can increase nutrient availability in acidic soils.
Italy has been one of the first European Nations to adopt a legislative framework on biochar as soil amendment in agriculture. The importance of existing legislative framework on biochar is related to a definition of what is defined biochar and which are the physical and chemical characteristic that the biochar must have to be applied in agriculture. The biochar, as soil amendment, can be made to achieve a wide exploitation and therefore contributing to the Climate Change Mitigation goal and supporting, at the same time, an efficient rural

development strategy and a circular based economy. The carbon-negative green market will generate a considerable positive impact on Green House Gas emission reduction and Climate Change mitigation, impacting also on other environmental categories (e.g. reducing water footprint of agriculture) and thus contributing to sustainable development and rural development.

1. I. Lewandowski, *Springer,* **2018,** https://doi.org/10.1007/978-3-319-68152-8
2. D. Woolf, J.E. Amonette, F.A. Street-Perrott, J. Lehmann, S. Joseph, *Nature Communications*, **2010**, *1 (5)*, 56.
Acknowledgments: Italian Biochar Association (ICHAR) is acknowledged

Lignocellulosic species for cultivation in degraded soils: sustainable biomass for biorefineries

Teresa Docimo[a], Monica De Palma[a], Marina Tucci[a]

[a]Institute of Biosciences and BioResources, Research Division Portici, National Research Council, via Università 133, 80055 Portici, Italy

email of presenting author: marina.tucci@ibbr.cnr.it

Giant reed (*Arundo donax* L., Poaceae) is an invasive perennial weed, whose high ligno-cellulosic biomass is being explored for energy and bio-based materials production. *A. donax* adaptability to harsh environmental conditions, such as salinity and drought, allows its use as sustainable ligno-cellulosic crop in marginal soils, avoiding competition with food and feed species. However, research is necessary to reduce the high propagation costs and to improve genotypes for tolerance to environmental stresses, especially salinity, which is the most diffused problem in marginal lands.
We set up efficient *in vivo* and *in vitro* propagation protocols and compared the obtained plantlets with those obtained through rhizome division in terms of biomass production in an open field two-year experiment. Although genetic variability in giant reed is reportedly low, a protocol for screening *A. donax* ecotypes for their tolerance to salinity set up in hydroponics[1] was found suitable for discrimination of NaCl-tolerance between several ecotypes collected in different hydro-geographic basins in South-Central Italy. The growth parameters better discriminating between ecotypes were relative 4th leaf width, and shoot and root dry weight. Three selected giant reed ecotypes were further characterized in order to explore cellular mechanisms responsible of salt adaptation.
Since salinity tolerance is a physiologically multifaceted trait, we conducted transcriptional profiling of *A. donax* leaf and root tissues for key genes known as mediators of ion homeostasis and transcriptional regulation under abiotic stress, after short (2 days) and prolonged (21 days) salt treatment (150 mM NaCl). In the root, all ecotypes responded to prolonged salinity with a strong transcriptional activation. In the leaf, distinct transcriptional behaviors between ecotypes emerged. Notably, one ecotype showed constitutive up-regulation of all the analyzed genes and a general downregulation upon short and prolonged NaCl treatment. Metabolic analysis of proline and ABA accumulation showed a significant increase in all ecotypes at both time points. Although severe NaCl stress did not induce phenotypic symptoms, lipid peroxidation was stimulated in all the ecotypes, consistently with higher induction of ROS scavenging-related genes. Overall, our

results suggest that salinity tolerance is associated with constitutive activation of molecular and metabolic reservoirs in *A. donax*. This work provides useful indications for the selection and breeding of improved *A. donax* germplasm. Further studies on adaptation mechanisms will help shedding light on the high tolerance of this species to environmental stresses.

1 R. De Stefano, E. Cappetta, G. Guida, C. Mistretta, G. Caruso, P. Giorio, R. Albrizio, M. Tucci. *Plant Biosyst.* 2018, 152, 911. doi:10.1080/11263504.2017.1362059.

Acknowledgements: This work was supported by the Italian Ministry of Education, University and Research (MIUR), grants PON01_01966 and PON03PE_00107_1.

Bioeconomy
and the microorganism

IBISBA 1.0: a Pan-European research infrastructure promoting industrial biotechnology as a mature manufacturing technology to support the growth of the circular bioeconomy

M. Di Fenza[1], M. Moracci[1,2], M. O'Donohue[4], and the IBISBA 1.0 consortium[5].

[1]Institute of Biosciences and BioResources-CNR, via P. Castellino 111, Naples, Italy
[2]Department of Biology, University of Naples 'Federico II', Via Cintia 21 - 80126 Naples, Italy
[4] Division of Science Food and Bioproducts Engineering-INRA, Rue de la Géraudière, Nantes cedex 03, France
[5]www.ibisba.eu.

Industrial Biotechnology, so-called Key Enabling Technology of the bioeconomy, is at a crucial point in its development, because it has been increasingly empowered by progress in life sciences research, and is now benefitting from synthetic biology. This new technology is a potential game changer for industrial biotechnology, because it brings engineering principles to biology and integrates into the wider bioprocess development scheme and the whole value chain from raw material to product, combining biocatalyst design with process and value chain conception.
To move industrial biotechnology further along the road to industrial maturity, progress in Research & Innovation is required to better translate new knowledge into innovative preindustrial processes that can be taken up by industry. This is vital to support the development of the European industrial biotechnology sector and Europe's circular bioeconomy transition.
Europe possesses a lot of research infrastructures that can be used to accelerate the development of innovative bioprocesses. Currently, these are mostly disconnected and thus unable to host the development of efficient R&I project pipelines. However, networking of individual infrastructure facilities is a viable way to overcome this problem, reduce duplication of research and cut investment, create synergy and stimulate cross-fertilisation among experts from different scientific theme areas.
IBISBA 1.0 is a research infrastructure project aiming to create and operate a Pan-European coordinated research infrastructure network to provide innovation services to industrial biotechnology. These services include the hosting of bioprocess development projects, helping to translate results into preindustrial innovation, the development of experimental workflows and standards to improve interoperability and reproducibility, a web-based repository for knowledge asset management and first-rate training for early career stage researchers. As a step towards reaching these ambitions, IBISBA 1.0 is operating a transnational access (TNA) programme, which provides subsidized access to a set of

research facilities. The TNA programme is open to all eligible researchers (1) wishing to translate their research results into pre-industrial innovation.
In the presentation, the IBISBA 1.0 project will be described, with special emphasis on how researchers in the Mediterranean area can benefit from its TNA programme and become stakeholders of the future EU-IBISBA infrastructure.

1. Industrial Biotechnology Innovation and Synthetic Biology Accelerator (IBISBA) 1.0 - H2020-INFRAIA Grant agreement n. 730976. Contact info: Michael O'Donohue, Project Coordinator. michael.odonohue@insa-toulouse.fr

[1] Researchers from EU member states and third countries. Researchers from European SMEs are exempted from the Open Data policy that applies to publically-funded researchers.

Biohydrogen and bioproducts from microalgae

Giuseppe Torzillo[a], Graziella Chini Zittelli[a], Cecilia Faraloni[a], Rosaria Lauceri[b]

[a]Istituto per la Valorizzazione del Legno e delle Specie Arboree, Via Madonna del Piano 10, I-50019 Sesto Fiorentino, Firenze.
[b]Istituto di Ricerca sulle Acque, Sede di Verbania, Largo Tonolli 50, Verbania.

email presenting author: giuseppe.torzillo@ivalsa.cnr.it

Microalgae are being evaluated for the production of bioenergy (hydrogen and biodiesel), and as potential source of high value compounds such as polyunsatured fatty acids (PUFA), pigments, and bioactive substances. The basic advantages of microalgae over conventional crops are that they do not compete for agricultural land use, do not pollute, the production per hectare is higher, they can use nutrients contained in wastewater (N, P), and flue gas as a source of CO_2. Among several biotechnological approaches, photobiological hydrogen production carried out with the model microalga *Chlamydomonas reinhardtii* has been intensively investigated in the recent years in our laboratories. It was found that sulfur-deprived *C. reinhardtii* CC124 cultures grown in laboratory photobioreactors (PBRs) equipped with an improved mixing system, the light conversion efficiency can reach 1.6% of PAR (photosynthetically active radiation), and up to 3.2 % of PAR which is remarkably high, with the D1 protein mutant L159I-N230Y which is considered one of the highest worldwide H_2 producers. Recently, a strain of *Chlorella* able to growth both under heterotrophic and autotrophic conditions is being investigated in our institute for hydrogen production. The strain is able to produce hydrogen both under light and dark conditions making it promising for outdoor operations. With this strain, it is possible to circumvent the problems of the sulfur-starvation procedure, which strongly limits the photobiological hydrogen production. However, the use of solar light is mandatory to make the process sustainable and scalable to an industrial level outdoors. A number of PBR designs have been devised and constructed for both production of energy and biomass. Several microalgal species have been selected in the laboratory for their lipid content. Among the marine strains, *Nannochloropsis* has showed to respond to nutrient stress (N and/or P deficiency) which promote lipid accumulation, with no significant decrease in productivity. This microalga can accumulate very high amount of lipids (up to 70% of the dry biomass) of which over 50% are triglycerides (TAG), the most suitable raw material for biodiesel production. The high amount of TAG after the starving process, makes *Nannochloropsis* one of the best candidates for large scale oil rich-biomass. Extraction and purification of phycocyanin from the cyanobacterium *Arthrospira platensis* (Spirulina) is another very promising marketable bio product. In 2018 the global phycocyanin market was valued about 112 million US$, and it is foreseen to reach a value of about 230 million US$ by 2028. PC is largely used in food industry, being one of the very few natural, safe blue colorant available. PC is used as natural cosmetic dye, fluorescent probe and in biomedical research. However, currently the widespread use of PC has been hindered by the high cost of large-scale extraction and, especially, purification, which remains problematic and expensive. The cost of PC as food colorant is relatively low, about US$ 0.35 per gram, because low purity is requested, but for cosmetic use it increases to about US$ 135, and for therapeutic and biomedicine applications, where a higher purity is required, PC cost can reach as much as US$ 4,500 per gram. Recently a simple and rapid method to purify phycocyanin from *A. platensis* based on membrane chromatography (MC) is being patented by us.

References

1. M. Seibert and G. Torzillo (2018). Microalgal hydrogen production: achievement and perspectives. The Royal Society of Chemistry, 2018.
2. Torzillo G., Chini-Zittelli G. (2015). Tubular photobioreactors. In “ Algal Biorefineries. Vol. 2 Products and refinery design. A. Prokop et al (eds), Springer Int. Publishing Switzerland.
3. Lauceri R., Chini Zittelli G., Maserti B., Torzillo G. (2018). Purification of phycocyanin from *Arthrospira platensis* by hydrophobic interaction membrane chromatography. Algal Research, 35: 333-340**.**

Photosynthetic microorganisms as a source of biohydrogen and bioplastics

Eleftherios Touloupakis

Research Institute on Terrestrial Ecosystems, National Research Council, Via Madonna del Piano 10, 50019, Sesto Fiorentino, Italy.

email of presenting author: eleftherios.touloupakis@cnr.it

Modern bioeconomy strategy addresses the production of renewable biological resources and their conversion into vital products and bio-energy. The proposed strategy intends to address specific challenges that the world is facing, such as: the depletion of natural resources; the impact of ever increasing environmental pressure; the replacement of fossil sources with sustainable, natural alternatives. Photosynthetic microorganisms are currently being investigated as potential source of biomaterials and biofuels such as bioplastic and hydrogen (H_2). Biological H_2 production is being evaluated for use as a fuel since it is promising substitute for carbonaceous fuels owing to its high conversion efficiency and high specific content. In our work biological H_2 production carried out with immobilized microalgae has been investigated. The synthesis of poly-3-hydroxybutyrate, a common type of polyhydroxyalkanoate (PHA) bioplastic, by a purple non-sulfur photosynthetic bacterium (*Rhodopseudomonas* sp.) has been also investigated.

Anaerobic digestion as attractive multistep bio-refinery: research and application with your bio-waste

Camilla M. Braguglia, Agata Gallipoli, Andrea Gianico, Daniele Montecchio, Pamela Pagliaccia, Barbara Tonanzi, Simona Rossetti

Istituto di Ricerca sulle Acque (IRSA-CNR)

email of presenting author: braguglia@irsa.cnr.it

Biowaste as food waste and sewage sludge are traditionally seen as a costly problem in economic and environmental terms. The challenge is to reverse this equation by designing more effective recovery and processing systems to turn these biodegradable waste into a source of value and contribute to restoring natural capital. Biorefineries could be a central technology in this perspective. Operating in a similar way to petrochemical refineries, they employ a range of techniques – such as pre-treatments, biological processes and enzymatic conversions – to transform organic feedstock into valuable chemicals, products and energy. Anaerobic digestion is a very attractive multi-step bioprocess that can be applied to a wide range of organic materials to generate biogas, leaving a nutrient-rich substance called digestate. Among the most typical forms of waste used for biogas production by Anaerobic Digestion (AD) there are sewage sludge and food waste. Their chemical-physical characteristics largely influence the AD performances leading to different results in biogas production and composition. An accurate characterization is an essential step also to determine whether a pre-treatment is needed and to help understanding which one is the most appropriate to modify the structural and compositional properties to make the substrate more accessible. Pre-treatment methods, as thermal hydrolysis, capable of significantly increasing the fraction of fermentable organic carbon can furthermore change the status of the feedstock to become more suitable for production of higher added value products as volatile fatty acids (VFAs). One of the step of the AD process, namely the dark fermentation, involves in fact the transformation of sugars, proteins and lipids into a mixture of products, e.g. acetic acid, butyric acid, propionic acid, with high market prices (800-2500 USD/tonn). At Water Research Institute, feedstocks pretreatments as AD processes are deeply investigated by means of a) Biomethane potential tests to understand the biomass performance in substrate degradation, to identify potential inhibition phenomena, and to evaluate the impact of pre-treatments; 2) in continuous operation with semi-pilot scale reactors to understand the AD process under dynamic loading conditions and to define limits of acceptable operative clauses, as correlations among microbial consortia. Long term AD of canteen food waste (FW), carried out at moderate organic load in semi-continuous mode was unstable, due to dramatic VFA accumulation because of high fermentative bacterial activity with respect to methanogenesis. By adding a small amount of sludge to the feedstock, no process failure was observed despite higher loads, allowing steady state methane yields (up to 0.31 $Nm^3CH_4\ kg^{-1}VS_{fed}$, corresponding to 55 Liters CH_4 per kg FW). The preliminary results from a novel platform approach to produce short chain fatty acids by acidogenic fermentation (35°C, controlled pH 6, HRT 4d) of the released organics (mainly sugars) after food waste thermal pretreatment combined with parallel bio-methane recovery from the residue, are very promising (up to 16 g VFA L^{-1}, composed by 37% of acetic and 37% of butyric acid).

Acknowlegements: Authors wish to thank Angelica di Benedetto for her experimental work during the Master Thesis Project with Campus Biomedico University of Rome.

Bioeconomy
and the environment

Towards sustainable livestock systems: reducing GHG emissions and improving production efficiency

Pierpaolo Duce[a], Alberto S. Atzori[b], Giovanni Molle[c], Alberto Manca[d], Giovanni B. Concu[e], Gianluca Cocco[f], Antonello Franca[g], Enrico Vagnoni[a]

[a]Institute of Biometeorology, CNR, Traversa La Crucca 3, 07100, Sassari, IT;
[b]Department of Agriculture, University of Sassari, IT; [c] AGRIS Sardegna, Sassari, IT;
[d]Laore Sardegna, Cagliari, IT;
[e]Department of Economy and Business Sciences, University of Sassari, IT;
[f]Department for the Environment Protection - Sardinia Region, Cagliari, IT;
[g]Institute for Animal Production System in Mediterranean Environment, Sassari, IT

email of presenting author: p.duce@ibimet.cnr.it

Despite the public controversies on the livestock sector, which is viewed as one of the main anthropogenic source of greenhouse gases (GHG) emissions, Mediterranean sheep supply chain can contribute to boost animal agriculture in the transition towards a more sustainable bio-economy-based society. GHG emission reduction is highly correlated with increasing production system efficiency and profitability (Jones et al., 2014), therefore improving the environmental performance of sheep farming could not only help combat climate change, but also enhance socio-economic sustainability of local supply chains (FAO 2006; O'Brien et al. 2016). SheepToShip LIFE (www.sheeptoship.eu), a 4-years project funded by the EU LIFE Programme Climate Action, clearly points in this direction. The overall objective of the project is to reduce by 20% in 10 years GHG emissions from the Sardinian dairy sheep sector. Its actions promote the inclusion of environmental strategies for the sheep sector into rural development programmes, focusing on i) efficiency of production systems and ii) valorisation of the ecosystem services provided by pasture-based farms. The immediate goals of the project are (i) to identify by LCA studies and to apply innovative solutions for the reduction of GHG emission, and (ii) to demonstrate the environmental and socio-economic benefits deriving from eco-innovation in the dairy sheep farming and dairy industry sector.

The activities conducted and the results obtained so far indicate that the reduction of GHG by 20% in 10 years in Sardinia seems technically feasible by increasing farm efficiency at flock and field levels. However, new policy strategies and measures are needed to support GHG abatement within and outwith the next Rural Development Programme. Future measures should be tailored as much as possible to background systems and co-designed by the stakeholders (especially farmers) using an approach similar to European Innovation

Partnership (EIP), and its impact should be evaluated using *smart* indicators (effective and cheap).
The SheepToShip LIFE initiative can thus serve as a model of good practices for other European contexts, and can contribute to improve the environmental performances of production processes and products of the European small ruminant sector.

1. A.K. Jones, D.L. Jones, D. L., P. Cross, *Agricultural Systems,* **2014**, *123*, 97.
2. FAO, *Livestock's Long Shadow*, **2006**, Rome.
3. D. O'Brien, A. Bohan, N. McHugh, L. Shalloo, *Agricultural Systems*, **2016**, *148*, 95.
Acknowledgments: With the contribution of the LIFE financial instrument of the European Union - LIFE 15 CCM/IT/000123.

Biosystems engineering: energy efficiency and environmental sustainability in agriculture

Paolo Menesatti,[a] Carlo Bisaglia,[b] Maurizio Cutini,[b] Corrado Costa,[a] Federico Pallottino,[a] Francesca Antonucci,[a] Marco Fedrizzi,[a] Giulio Sperandio,[a] Mauro Pagano,[a] Roberto Tomasone,[a] Francesco Gallucci [a]

[a]Consiglio per la ricerca in Agricoltura e l'analisi dell'economia agraria – Centro di ricerca Ingegneria e Trasformazioni agroalimentari, Via della pascolare 16, 00015 Monterotondo (RM)
[b]Consiglio per la ricerca in Agricoltura e l'analisi per l'economia agraria – Centro di ricerca Ingegneria e Trasformazioni agroalimentari, Via Milano 43, 24047 Treviglio (BG)

email of presenting author: paolo.menesatti@crea.gov.it

Currently, most of the energy in the world is obtained from non-renewable resources, such as coal, oil and natural gas (fossil fuels). The use of energy from fossil fuels has long-term negative effects on human health and the environment (greenhouse gas emissions, air pollution). These factors have given new impetus to the development of energy and products (biomaterials) from renewable resources. Bioenergy constitutes an opportunity for "sustainable growth" that requiring special consideration. Technological progress and biosystem engineering could be the strategic innovation taking agromechanics towards greater bioenergy process efficiency, sustainability and respect for the agro-environment. As reported by Comparetti et al. [1], biosystems engineering can be defined as the engineering discipline related to the overall agricultural activity (e.g., production, processing, storage and distribution) including structures, equipment and machines, environmental control for animal health and welfare, post-harvest technology, process engineering, ergonomics and safety, etc.). In Italy there are many public and private institutions that handle with bioenergy related topics and projects. One of these is the CREA, the most important research organization in agriculture in Italy, that deals with also of innovations in agro(bio)energy. It has many projects, funded by the Mipaaft (Italian Ministry of Agriculture), and in collaboration with other institutions, which concern these issues. It is working on agricultural technologies both for direct or indirect energy production and, as latest address, on energy efficiency and saving in agriculture. Other key issue is represented by precision agriculture for increasing energy efficiency in agromechanics operations. It is also involved in experimentally assessing the attitude of "biobased" oils to reduce the impact of lubricants on the environment. Finally, another focal point for the energy and environmental sustainability, concerns the reduction of agricultural machineries and bioenergy plants emissions of polluting such as greenhouse gasses. Generally, these activities could solve problems relating to the production, handling and processing of biological materials for food, feed, fiber and fuel and preserve natural resources and environment quality designing and producing machine systems. CREA Agricultural engineering research center is deeply involved in technology application and demonstration for environmental sustainability with focus to digital and precision agriculture.

1. A. Comparetti, P. Febo, G. Scarascia Mugnozza, **2008**, Definition of the emerging Biosystems Engineering discipline in Europe: the current situation in Italy. Education and Research in Biosystems Engineering in Europe, 81.

Phytomanagement of contaminated agricultural areas: coupling the soil restoration to the recovery of exploitable resources

Fabrizio Pietrini, Laura Passatore, Fedra Francocci, Angelo Massacci, Massimo Zacchini

Research Institute on Terrestrial Ecosystems, National Research Council of Italy, Section of Montelibretti, Via Salaria km 29.300, 00015 Monterotondo (Rome), ITALY;

email of presenting author: massimo.zacchini@cnr.it

An increasing threat to food safety and ecosystem services is represented by land degradation. A primary cause of such degradation, apart from the effects of climate change, is due to the contamination caused by anthropogenic activities. Regarding the agricultural soil, the overuse of chemicals and the waste release from industrial processes resulted in a large number of contaminated sites over Europe. Such a situation requires the restriction to the cultivation of these sites in perspective of their reclamation. Among the different environmental restoration technologies, those based on natural processes are largely studied and successfully applied, especially in sites characterised by moderate and diffuse contamination. In this regard, the phytomanagement is recognised as an effective approach to carry out a risk management strategy [1], being constituted by an array of gentle remediation options (GROs) that can be applied as a part of integrated site risk management. Specifically, the phytomanagement relies on the choice of suitable plant species for the recovery, risk mitigation and valorization of contaminated sites [2]. Therefore, the phytomanagement represents an improvement of the phytoremediation biotechnology, exploiting in a broader way the ecological benefits offered by plants. As a consequence of the agricultural site contamination, the restriction of cultivation and grazing produces a loss of income for farmers without restoring the environmental quality. In this context, the phytomanagement can represent a valuable choice, offering the possibility of cultivating non food crops that, besides the capability to mitigate the soil contamination, can satisfactorily grow and produce biomass and other bio-products for multiple profitable utilisations. In this way, while restoring soil, the crop cultivation can generate revenue for farmers by exploiting the biological resources for many different industrial uses, thus representing a valuable example of a bio-based economy. For many years our research group has been targeting the selection of best performing plant genotypes for the remediation of contaminated soil and water. In the last years, efforts were made to focus on case-studies, both at pilot and lab scale, evaluating the profitability of the phytotechnologies. Specifically, the agricultural contaminated area of the Valle del Sacco (Lazio Region, Italy), recognised as National Interest Site by the Italian Ministry of Environment for its huge extension and diffused contamination by metals and organics, was targeted. Different experimental trials were performed over time with non-food crops focusing on both organic and metal contaminants. In these trials, fast growing trees like poplars and industrial crops like hemp proved their suitability for risk mitigation and soil recovery actions, producing different exploitable bio-resources ranging from biomass for energy and fiber for paper industry to seeds for industrial oil, thus bridging phytotechnologies with sustainable bioeconomy.

1. A.B. Cundy, R.P. Bardos, M. Puschenreiter *et al.*, *J. Environ. Manage.*, **2016**, *184*, 67.
2. M.T. Domínguez, T. Maranón, J.M. *et al.*, *Environ. Poll.*, **2008**, *152*, 50.

Wood-based circular economy: timber, composites, fibers and energy

Martino Negri [a], Andrea Polastri [a], Giovanni Marino [b]

[a] *CNR-IVALSA, Istituto Valorizzazione Legno e Specie Arboree, Via Biasi 75 38010 San Michele all'Adige (TN), Italy*
[b] *CNR-IVALSA, Istituto Valorizzazione Legno e Specie Arboree, Via Madonna del Piano 10, Sesto Fiorentino (FI), Italy*

email of presenting author: negri@ivalsa.cnr.it

Wood is a sustainable self-producing raw material suitable for a wide range of products in the primary woodworking industry (sawn wood, wood-based panels, etc.), in the pulp and paper industry (wood pulp, paper, paperboard, etc.), in the secondary wood processing industry (furniture, timber buildings, engineered structural timber) and in wood bio products (wood-plastic-composites, biopolymers, etc.). Furthermore, wood products and by-products are used for energy purposes as fuels: fuelwood, woodchips, wood residues, pellets, bioethanol. This work deals with a few research frameworks presently ongoing, focused on the innovative use of wood and/or wood-based technologies in the perspective of closing the circle forests/products/energy/recycling: timber as such, composites, tissues, syngas and biochar. The innovative pre-fabricated timber system for emergencies, developed by the TRE3 project (CARITRO, Lund University and Fraunhofer It.), is based on XLam type cross glued panels with inclined sawn elements, suitable for an easy assembly process on site, fast and simple building process and, finally, conceived for disassembly at the end of life and suitable for reuse. It is fully sustainable since it is based on the use of after-process Xlam panels residues.
La Fibra dell'Agriselvicoltura Trentina (TAF/17, FEASR PSR PAT 2014-20) aims to exploit the potential of the alpine timber through two different approaches. The use of the cellulose extracted from wood is tested for ropes, tissues and nets in different the agro-food chain processes; the tests are either performed in the fields by farmers for different agronomical processes, either in laboratory as aging and characterizing tests. All the stakeholders – farmers, trade organizations, consumers – are involved in the testing, communication and

disseminations campaigns. In the same framework we are developing bio-resins/wood composites – conceived for food packaging - assembled by using thin (150 micron) wood layers and bio-based resins, by using an innovative process for the production of the wood layers. The goals of InnovaChar (CARITRO and BiokW) are about the production of syngas for heat and energy production by using low quality bio-residues (thanks to a small scale industrial plant able to process other raw materials than wood chips) (1) and the use of the byproduct (biochar) for innovative purposes, such as adsorbing matrix to amend the volatile emissions of manure (IBIMET and CREA).

The above described researches encompasses renewable biological resources and their conversion and waste streams into value added products, such as bio-based products and bioenergy, according to the European Union guidelines and efforts.

1. Martino Negri, Marco Fellin, *Small scale plants for energy production: environmental impact of biomasses pyro-gasification*, 2nd International Symposium "NEW METROPOLITAN PERSPECTIVES". ISTH2020, Reggio Calabria (Italy), 18-20 May **2016,** 1877-0428 © 2016 by Elsevier Ltd.

Bioeconomy

biological sources for a sustainable world

Program

BioEconomy:
biological sources for a sustainable world

10.00 – 10.20 Opening Ceremony

- **Michele Muccini.** President Area della Ricerca Roma 1, CNR
- **Francesco Loreto.** Director CNR-DiSBA
- **Massimo Inguscio.** President Consiglio Nazionale delle Ricerche
- **Massimiliano Smeriglio.** Vicepresident Regione Lazio

Chair: **Francesco Loreto**

10.20 Laura De Gara. Università Campus Bio-medico, Roma. *Bio-economy - A challenge of knowledge integration for the Society 5.0*

10.45 Fabio Fava. Alma Mater Studiorum Università di Bologna. *Bioeconomy in Europe and in Italy: the Italian Bioeconomy strategy and the opportunities offered by the EU Commission for sustaining it*

11.10 Francesco Cellini. Cluster Lucano di Bioeconomia.

Bioeconomy and the food system. Chair**: Antonio Raschi**

11.35 Francesco Gai. CNR-ISPA. *The Circular Economy applied by insects: the Black Soldier Fly Experience*

11.45 Antonello Franca. CNR-ISPAAM. *The contribution of agro-silvopastoral systems for bioeconomy in Italy*

11.55 Rosaria Ciriminna. CNR-ISMN. *A circular economy approach to omega-3 extraction*

12.05 Stefano Predieri. CNR-IBIMET. *Edible jellyfish: introducing to a new sustainable food system*

12.15 Francesco Meneguzzo. CNR-IBIMET. *Controlled hydrodynamic cavitation as a tool to enhance the properties of biological sources*

12.25 *Discussion*

12.40 ***Lunch***

Chair: **Mauro Centritto**

14.00 **Giuseppe Scarascia Mugnozza.** Università della Tuscia. *Forest and wood bioeconomy*

14.25 **Mauro Majone.** Sapienza Università di Roma. *An Urban Biorefinery to convert organic waste into bio-based plastics: the H2020 RES URBIS project*

Bioeconomy and agriculture. Chair: **Luisa Mannina**

14.50 **Salvatore Antonino Raccuia.** CNR-ISAFOM. *Cultivation of Cardoon, biomass species for green chemistry, with a circular economy approach*

15.00 **Giuseppe Sorrentino.** CNR-ISAFOM. *The CNR and Hemp chain: a new opportunity for Agriculture in Southern Italy*

15.10 **Lorenzo Genesio.** CNR-IBIMET. *Multifunctional agriculture for bioeconomy: chlorophyll-deficient crops for climate change mitigation*

15.20 **Francesco Vaccari.** CNR-IBIMET. *Biochar for bioeconomy*

15.30 **Marina Tucci.** CNR-IBBR. *Lignocellulosic species for cultivation in degraded soils: sustainable biomass for biorefineries*

15.40 *Discussion*

15.50 ***Coffee break***

Bioeconomy and the microorganisms. Chair: **Alberto Battistelli**

16.05 **Mauro di Fenza.** CNR-IBBR. *IBISBA 1.0: a Pan-European research infrastructure promoting Industrial Biotechnology as a mature manufacturing technology to support the growth of the circular bioeconomy*

16.15 **Giuseppe Torzillo.** CNR-IVALSA. *Biohydrogen and bioproducts from microalgae*

16.25 **Eleftherios Touloupakis.** CNR-IRET. *Photosynthetic microorganisms as a source of biohydrogen and bioplastics*

16.35 **Camilla M. Braguglia.** CNR-IRSA. *Anaerobic digestion as attractive multistep biorefinery: research and application with your biowaste*

16.45 *Discussion*

Bioeconomy and the environment. Chair: **Giorgio Matteucci**

17.00 **Pierpaolo Duce.** CNR-IBIMET. *Towards sustainable livestock systems: reducing GHG emissions and improving production efficiency*

17.10 **Paolo Menesatti.** CREA. *Biosystems engineering: energy efficiency and environmental sustainability in agriculture*

17.20 **Massimo Zacchini.** CNR-IRET. *Phytomanagement of contaminated agricultural areas: coupling the soil restoration to the recovery of exploitable resources*

17.30 **Martino Negri.** CNR-IVALSA. *Wood -based circular economy: timber, composites, fibers and energy*

17.40 *Discussion*

ISBN 978-88-97987-21-5